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Murray (John)

J Menston

Cambridge 23 Sept [illegible] —

Mr Harvey presents his compliments to Professor Henslow & requests acceptance of a copy of his 'Phycologia Britannica'

21-a. 4733

THE
PHYSIOLOGY
OF
PLANTS.

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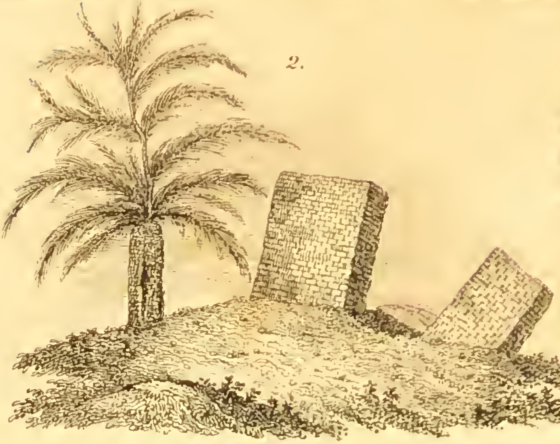

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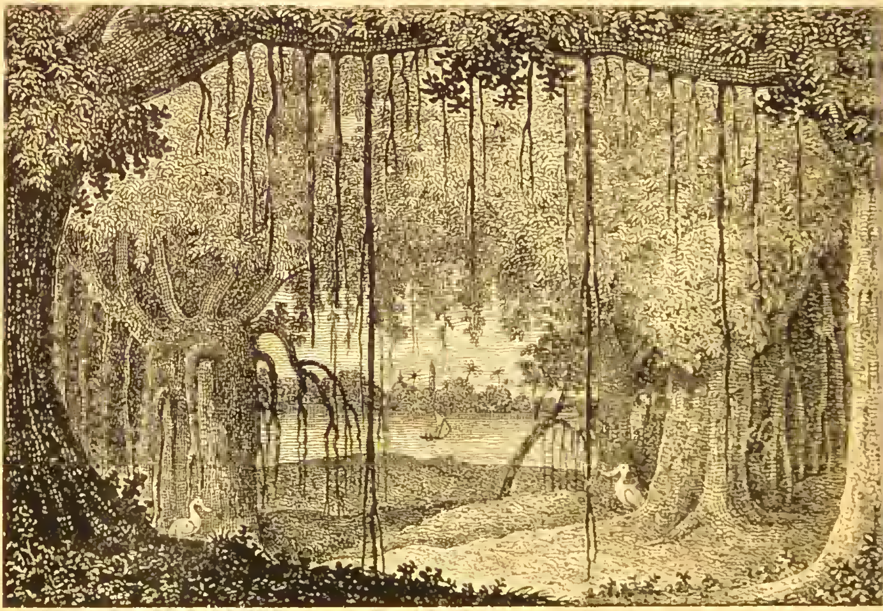

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THE

PHYSIOLOGY

OF

PLANTS;

OR THE

PHENOMENA AND LAWS OF VEGETATION.

'Consider the Lilies of the Field how they grow!'

LONDON:

JOHN MURRAY, ALBEMARLE-STREET.

1833.

4733

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THE RIGHT HONORABLE

HENRY, LORD BROUGHAM AND VAUX,

CHANCELLOR OF GREAT BRITAIN,

F.R.S.

&c. &c. &c.

THIS VOLUME IS

INSCRIBED, WITH THE HIGHEST RESPECT,

BY THE AUTHOR.

ADVERTISEMENT.

THE Physiology of Vegetation has been my favorite and first pursuit,—the chief source of my earliest enjoyment. The advance of years, so far from weakening its impressions, has rather strengthened them. When 'doubts without, and fears within,' have assailed me, I have looked upon the flower, and remembered the important lesson that it ought to teach—"If GOD so clothe the grass of the field, which to-day is, and to-morrow is cast into the oven, shall he not much more clothe you?" I have then rejoiced in this assurance of a watchful and overruling Providence, and the heart has regained its lost tranquillity.

The great and good in every age have found their purest sources of enjoyment in pursuits like these; and their influence over the heart and life, is a sufficient evidence that their tendency is happy. Almost the earliest adventure of playful infancy is to sally forth to cull daisies, and gather buttercups. While we contemplate children thus engaged,

'Wi' flichterin' noise an' glee;'

we are forced to acknowledge that recreations like these must be innocent, exhilirating and healthful.

"Non omnes arbusta juvant, humilesque myricæ,"

is indeed a truism; but after all, few topics of research can vie with the delightful study of plants, when abstracted from the tedious and monotonous round of a dull and prosing nomenclature. As our warrant for the excellence of the pursuit, we can make our emphatic appeal to the highest of all authority,—the statute-book of heaven; and it is briefly comprehended in these memorable words,

"Consider the lilies of the field."

I have been as concise as possible, and in endeavouring to be so, fear I may have run into the opposite extreme: and in consequence, my transitions, in many instances, may be considered abrupt. Some partial repetitions, for better elucidation, were found unavoidable. Technical descriptions have been avoided as much as possible; and the nomenclatural description of details, has been ably accomplished by others. I have consulted the best authorities; not at second hand—and these have been very many. After all, the present little volume is but an imperfect outline of an extensive field of enquiry: but by discarding the mention of multitudinous opinions and theories, I have had the more room for facts. A great many of these have been verified by personal observation;—for the rest, I have used the best discrimination in my power. Several interesting features, such as the geography and physiognomy of vegetation, are left untouched; but the question is not how far it might have been extended, but whether my prescribed limits have been judiciously supplied. My MS. materials were sufficiently ample, but condensation was my aim. I must acknowledge, however, that one great object I had in view, was to shew the wisdom and beneficence of the supreme CREATOR, in the structure and adaptation of vegetation, and to combat the rash and irrational speculations of a few modern pseudo-philosophers:—assumptions, that have given me much pain, and excited considerable surprise.

10 AUGUST, 1833.

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CHAPTER I.

Introductory Observations——Characteristic distinction between Animal and Vegetable Being——The Structure and Attire of Plants.

EACH of the domains of Natural History is fraught with its peculiar interest, and to the eye of reason is invested with a charm; beauty and harmony pervade the wonderous whole, and afford incontestible evidence of the power, wisdom, and goodness of their Almighty Author. We need not soar on the wings of astronomical science, and plunge

> "——— into the immensity,
> Behind the veils of that blue sky,
> Where GOD's sublimest secrets lie——"

in search of intelligence and design; there is enough within our reach of what is wonderful—tangible elements of truth—rays of knowledge, prismatic and beautiful, amply sufficient to supply our lives with materials for thought and reflection, and satisfy the most restless mind. These rays may indeed fall pointless on the morbid vision, but this does not impair their intrinsic excellence.

Animal nature, from its locomotive character, is not so passive under examination as vegetation is. It flits and changes like the celestial curtain of the aurora. It is more beautiful on the wing, or wild and in the woods, than when fettered and imprisoned, because in the latter case we see only in part the adaptation of the indigenous habits of animals. The notes of the 'attic bird' lose all their charm, when it is encaged. We may however study vegetation at our leisure, either in the garden or in the field; our pleasures spring up beneath and around us; and though some plants are sufficiently sensitive and irritable, and are presented to our view in a modest attire, they will not conceal themselves, or shrink from contemplation, and the more closely they are examined, the more beautiful and wonderful will they appear.

The phenomena of vegetation formed a part of the studies of the greatest sages of antiquity; and he "whose fame was in all nations round about,"—"who was wiser than all men" in those times,—"than Ethan the Ezrahite, and Heman and Chalcol and Darda, the sons of Mahol"—"spake of trees, from the cedar tree that is in Lebanon, even unto the hyssop (moss) that springeth out of the wall:" they have no voice, and they are tuneless; but there is in plants a silent emphasis, and their insignia are beautiful. They supplied emblems for proverbs and parables, and in the east still continue to be the fruitful field where fancy delights to rove.

The rose of Sharon, and the "Lily of the vallies," the twice blooming rose of Pestum, and the lily of Anacreon,* are assemblages of pleasing images. A garland of flowers forms an expressive oriental love-letter, and the bul-bul and the rose are twin adjuncts in many a Persian poem. The daisy has been the poet's favorite, from Chaucer to Burns. The "Blue Bells* of Scotland," become almost a national characteristic, or at least have a fancied local charm. Even, in the heraldry of kingdoms, flowers, &c. are sometimes introduced as mystic symbols. For instance, the Fleur-de-Lis (Iris) of France; the Rose of England; the Thistle of Scotland, and the Shamrock (oxalis acetocella?) of Ireland. When the natives of Nubia would express their attachment to the land of their birth, it is Nubia, "the land of roses." Eastern poets have fancied the earth a flower, and India its blossom. Even the predatory hordes of Arabs, as they range the burning plains of Chaldea, will pause awhile to contemplate the "Werd-el-Shems," or *Flower of the Sun.*

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* *Pancratium maritimum?*

In classic times, the myrtle was the symbol of love;‡ the olive of peace; and the laurel and the palm were emblems of victory. The oak supplied the foliage of the civic crown; and the cypress, type of immortality, flourished near their temples. Beneath the venerable shade of the banian-tree does the devotee of Brama, on the plains of Hindūstan, perform the offices of his religion, and cultivate his abstractions. On the birth of a son, the Turks plant the oriental plane, and when he dies, substitute the cypress.

---

* The 'Blue Bells of Scotland' are the flowers of *Campanula rotundifolia;* and the 'Harebells,' the *Scilla nutans.*

‡ In Damascus, the myrtle is planted, by the hand of affection, at the grave.

The beautiful forms of flowers and trees became a fertile source of admiration and ornament in every age. The "goodly cedar" was esteemed the "glory of Lebanon;" and in the tabernacle that was reared in the Wilderness, vegetation supplied the pattern of its beautiful furniture. The golden candlestick, "branching like the almond tree," was adorned "with its knops and flowers." The pomegranate, and the palm and the lily-work of the temple, constituted some of its richest and loveliest ornaments.* In aboriginal Egypt, the Persea, in alternations of leaves and seeds, adorned the seats of their deities; and the lotus appears to spring up by the side of the throne of Osiris. In bud and blossom, indeed, the lotus forms an important symbol, not only in the temples of Egypt, but those of Hindūstan, and are to be descried among the wonders of Elora. The lotus surmounted the massive columns of that "land of gods," and formed their capital, as the acanthus did that of the Corinthian column. A pure source yielded these elegant patterns; and in the composition of the arabesque; leaves, flowers, and fruit are always prominent. The honeysuckle, the rose, and others, are frequent ornaments in the modern freize; and in that of the Parthenon of Athens, may be even found the capsule of the poppy.

Pliny called the flower or blossom, the "joys of trees;"

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* "Upon the tops of the pillars was lily-work." "The brim was wrought with flowers of lilies." 1 Kings, c. vii. v. 22, 26.

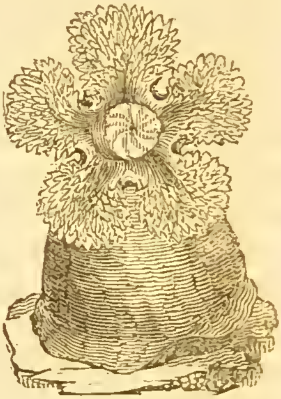
and in sacred writ, the rose-bud is the symbol of joy and gladness: "Let us crown ourselves with rose-buds, and let no flower of the spring pass away:" such is the language of mirth and jollity. Flowers of the ornithogalum corymbosum are entwined among the hair of the Persian females, and are exeeedingly ornamental. We have seen the peasantry of the country round Ferrara come to market crowned with garlands formed of the flowers of the tube-rose. In the South Sea Islands, the gardenia, hibiscus, and amaranthus, are often woven by the natives into the most graceful wreathes and garlands; and worn on their brows. In truth, some of the most exquisite imagery of the sacred volume derives its adumbrations from the kingdom of vegetation: the symbols of sadness are the bulrush and the willow. The "upright" is assimilated to the palm-tree, and described as spreading his roots like Lebanon: the figtree, the vine, and the olive, are associated with tranquillity and safety; and when the DEITY, speaking by the prophetic bard, represents a scene of happiness, and a reign of peace, the imagery belongs to the scenery of trees; "I will plant in the wilderness the cedar, the shittah-tree, and the myrtle, and the oil-tree; I will set in the desert the fir-tree, and the pine, and the box-tree together." Thus too, "I will be as the dew unto Israel: he shall grow (blossom) as the lily, and cast forth his roots as Lebanon. His branches shall spread, and his beauty shall be as the olive tree." These observations seem sufficiently to corroborate the pure and serene nature and tendency of such pursuits, and as constituting the materials of intellectual enjoyment. While the chemist is watching over the processes of the alembic and the crucible, amid the fumes and vapours of the laboratory, and his health is undermined, the student in vegetation reaps his laurels at a healthier shrine.

With these preliminary remarks, we may now advert to the characteristic difference which obtains between animal and vegetable being; and these sometimes run into each other by almost imperceptible shades; nor is the definition so very easy as might at first sight be imagined. Animals that belong to the *radiata,* possess somewhat of the character of vegetation. The alcyonia, and lily encrinite, form memorable examples. The figure represents the *pentacrinus europeus,* found alive by Mr. Thompson, in the Cove of Cork. One of the pentacrini has also been discovered on the coast of Barbadoes; and of this there is a beautiful and interesting specimen in the museum of the Geological Society at Somerset House, with a joint of the the fossil pentacrinus placed along it, to shew its perfect correspondence and identity. The actinias or sea-flowers, however, bear the most extraordinary resemblance to plants: some are found attached to rocks on the coast of the British islands; but the colours are more gaudy and brilliant in tropical climes. Savigny found the *Diozoma mediterranea,* or violet

diozoma, near the island of Yvica. It is a light violet colour, the tint deepening towards the edge. In this species of radiata, there are six lanceolate tentacula.

The "animal flowers" were first particularly noticed by Mr. Ellis, and specimens sent from the West Indies to Lord Hillsborough: a great variety of these have been described; and the specific distinction is derived from an assumed resemblance to particular flowers, &c.; thus we have *actinia sociata,* the clustered animal flower, *A. Aster,* sea star-flower; *A. Anemone,* sea anemone; *A. Helianthus,* sea sun-flower, &c. Actinias were called by old writers *urtica marina,* or sea nettle, from their supposed stinging property. The tentacula of the actinia are disposed in regular circles, and tinged with brilliant and diversified colours, somewhat resembling the petals of fringed and radiated flowers, such as the marigold, carnation, &c. Actinias are found fixed on rocks, and attached by suckers, at low water: they are however locomotive, and can thus shift their situation, but their motion is slow. An orifice in the centre forms the mouth; it is capable of great extension, and can swallow entire, mussels, crabs, &c.; and when it has sucked out the fish, it ejects the shell.

The Abbe Dicquemaire describes a curious struggle between two of these sea-flowers, for a portion of fish. Each held fast hold of the opposite extremity, and continued to swallow the morsel until their mouths were in contact: this contest for the mastery was continued for three hours, when one of them abandoned its hold, and the other slowly gorged the *morceau.* Through the same opening, the actinia produces its young alive, already fully formed and supplied with tentacula: these immediately fasten on the rock, like the parent actinias, and shift for themselves. The actinias are singularly beautiful for their lively tints in the West Indies, and are more active and vigorous in tropical countries; but they are also found on the coasts of England, as Sussex and Cornwall; we have also seen some beautiful actinias on the rocks near Douglas, in the Isle of Man. The figure represents the actinia dianthus, or sea-carnation, of a rich crimson colour, from the West Indies.



When some persons descended in a diving-bell to the wreck of the Royal George, off Spithead, they found the deck covered with numerous sea anemonies, giving it the appearance of "a gay flower garden."

The processes of assimilation, with the possession of a digestive sac or pouch, locomotion or change of place, sensation, &c., have all been assumed as characteristics in the line of demarcation between animal and vegetable being; but when these come to be more closely examined, it will be found that they are by no means so definite and invariable as may, at first sight, be imagined. Sir James Edward Smith considered satisfactory the view sustained by Mirbel; namely, that the chief difference between plants and animals consisted in the appropriation and assimilation on the part of the former, of inorganic materials, such as earthy and gaseous matter, &c.; while organic matter, as derived either from a vegetable or animal source, was essentially requisite for the support of animal nature. This assumption, however plausible it may seem at first sight, will not bear scrutiny. Neither the functions of animals nor vegetables can go on, and be perpetuated without aërial media; and its combination in animal products is as manifest as those of vegetation. The phosphate of lime, which forms the solid constituent of bone, and secreted in accurate proportions, and at proper periods, may be that separated from the food taken as support, and we certainly know that if calcareous matter be excluded from domestic poultry, the eggs are entirely without shells. Insect life has been supported by mineral substances; an instance of this kind is adduced by Mr. Kirby; and a spider, imprisoned in a box along with sulphate of zinc, was found to have devoured a considerable portion of it. A great variety of objections might indeed be easily stated against this definition. External form and appearance would be equally deceptive, as may be exemplified in some of the radiata already mentioned: nor would locomotion be a safe test of discrimination, since some animals seem to be scarcely susceptible of change of place; though corallines and sponges must be considered as merely the fixed tenements of the animals which inhabit them. Some plants, however, have no fixation whatever; and there are marine, and fluviatile plants, which possess only an uncertain and temporary attachment, float on the surface of the water, and are moved hither and thither. Thus the *laminaria pyrifera* (Lamouroux), a species of fucus, upwards of 800 feet long, and the *fucus natans* or sargasso, in the Gulph of Florida and elsewhere, occupying an immense extent of the surface of the ocean, are memorable examples of the same kind. The *callitriche acquatica*, or water star-grass, floats until it flowers, then sinking, strikes root at the bottom, and there matures its seeds; the young plants, which spring from these seeds, rise to the surface, and float in their turn. The globe crow silk (conferva ægagropila) is a wanderer on the waves—vagabond on the surface of the deep, it is the playball of the billows, having no fixed habitat. Sometimes it is found in lakes, but the sea is its general domain. The lemna, or duck-meat, forms a common and familiar example of the same kind.

Neither can we accurately pronounce on the entire absence of sensation in vegetation. Some plants exhibit remarkable evidences of irritability; and though this is not necessarily connected with sensation and consciousness, we are by no means supplied with sufficient data to pronounce a negation. The irritability evinced in the lower part of the filaments, which support the anthers of the barberry, when touched, and that in the flower of the apocynum are remarkable phenomena, though inconclusive as to consciousness; of a similar description, is the singular motion of the leaves in the hedysarum gyrans, which grows on the banks of the Ganges, as well as the irritability of the extraordinary prolongations in the leaves of the dionæa mucipula; the pinnate foliage of the mimosa pudica, &c. With these might be cited the not less striking phenomena of the *oscillatoriæ,* where the oscillation of the filaments is in constant motion. To be described in a subsequent chapter.*

We might add to these examples a variety of others: it may however suffice to observe, that the *echinella,* or hedgehog-wort, so called from its armature, has the faculty or power of locomotion, and shifts its position: when the globular vesicles of the *vaucheria clavata* separate from their attachments on the parent stem, they seem to possess animality, swim about as if they were possessed of volition, at length become stationary, shoot forth the rudiments of a plant, ramify; and being matured in eleven days, evolve their living seeds. The natural grafting of one of the *zygnemata,* allied to the confervæ, is a very extraordinary process, and bears a strong affinity to animal life.

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* We have not thought it necessary to advert to a peculiar and marvellous vegeto-animal being, stated to have been announced in the Italian journals, as recently discovered in the interior of Africa. It is described as being in the form of a spotted serpent, and dragging itself along the ground. In lieu of a head, there is a bell-shaped flower, which contains a viscid liquid. Insects thus attracted, enter the flower, and are caught, the flower immediately closing upon them. Their decomposition is said to afford nutriment to this singular being; the undecomposed portions being ejected by two lower spiral orifices. This vegetable serpent is further represented as having a skin resembling leaves, white and soft flesh, and in place of a vertebrated skeleton, a cartiliginous frame, filled with yellow medulla. This seems to belong to the class of "chimeras and gorgons dire;" and we are reminded forcibly of the *hoax,* some years ago, of the "Trottel plant," played off by an individual of Greenock, whose wit exceeded his prudence and discretion.

A variety of curious examples of these singular phenomena will be given, and are only now incidentally adverted to, in proof of the difficulties which interfere with a satisfactory definition of the problem, affecting the distinction between animal and vegetable life. It is not easy to see where each of these domains of natural history ends, and the other commences; they dovetail with each other; and glide by such imperceptible lines into one another, as we approach their confines, that the precise termination of their links of being are determined with difficulty, and our conclusions are necessarily equivocal.

That there is a well marked and defined distinction cannot be doubted; but our imperfect knowledge of the physiology of both, forms an insurmountable barrier to accurate deductions: nor will chemical analysis do much in the way of assistance, because nitrogene, though comparatively rare, as an ultimate product, is nevertheless met with in vegetation. There are still however phenomena in the structure and circumstances of plants, that enable us to form a sufficiently accurate judgment, at least adequate to all practical purposes; and, if what is wanting teach us the lesson of HUMILITY, it may certainly rank as one of the brightest achievements of mental research. The unwelcome truth may as well be honestly confessed,—*little comparatively can be truly known.* Equally absurd are the futile endeavours that have been made to establish an analogy between vegetables and animals, whether in reference to structure or functions; by pressing into the service statements, whether true or false, when they happen to square with preconceived fancies; and rejecting others, when their evidence appears to be contradictory. Such a task requires a master-talent for sifting evidence,—a keen perception of the phenomena,—an extensive acquaintance with multitudinous facts,—and last, not least, a personal and intimate knowledge of plants and animals, in countless variety: these are acquirements that fall to the lot of few. Self-conceit may rush on the bold adventure, but sober science will be more wary. Dissatisfied with all that I have met with on the subject under review, and being unprepared to substitute a definition of my own, I abandon the question, having stated the difficulty, to its own weight. It is better to pursue the evidence of tangible phenomena, than indulge in fruitless and unprofitable speculations, especially where loose analogies will avail us nothing: a plant is indeed " a varied thing." It is " on the isthmus of a middle state," that we are chiefly perplexed and puzzled in sketching the line of demarcation between the domains of animal and vegetable nature: as we recede from the extremes which skirt them, the difference becomes obvious enough, and the distinctive features are too palpable to be mistaken, however difficult be the problem which involves their solution. In many familiar things there is a self-evidence, which carries conviction, though the phenomena may defy definition: of this description is the simple question,—what is life?

The vegetable system, like the animal machine, is a curious structure, though its form be less complicated. The plant will be found admirably supplied with the requisite organs, put in motion by interesting mechanism. There is an elegant symmetry in some, and in others singular and fantastique forms; yet in both the arrangement and adaptation are equally wonderful. The vegetable being is built up and nourished by certain materials, that it collects generally from the earth, where its roots are usually fixed, by means of certain organs, and circulating through the pipes, with which its system is supplied, are appropriated and assimilated: these peculiar organs perform their several functions, and, as in the animal economy, deposit their respective elaborations, where the secreted substance is wanted, and no where else. In the animal machine, unless when morbid action supervenes, oseous matter is not precipitated among the muscles, nor muscle among the nerves; so in the other, the elaborated sap contributes what is essential to the formation of *alburnum* in its ascent; and in its descent, what is required for the growth of *liber*. The plant by these means increases in size and strength, and from an acorn becomes an oak, "whose seed is in itself." Through these curiously constructed systems of pipes and cells, the noiseless and unobtrusive process of vegetation moves on, and the life of the plant is supported and continued. Its ultimate and external evolutions are subjects of interest and admiration, in the beautiful attire which adorns the plant; but the delicate and subtile chemistry, over which life immediately presides, is intercepted by a veil, which defies the philosophy of man, with all the keen scrutinies of his research.

Vegetable physiology is indebted to the labours of a multitude, who have successfully interrogated many of the most elaborate phenomena of vegetation. The names of Hales and Spallanzani, Linneus, Mirbel, Sennebier, and Ingenhouz, are prominent in the list, as well those of Keith, Decandole, Dutrochet, Knight; and others, whom it would be altogether superfluous and unnecessary to name.

Botany is a simple term, but embraces a most comprehensive science. It is a grievous mistake to confine its application to mere nomenclature, and the limited knowledge of being able to discriminate one plant from another. If our studies terminate in these things, we are content with its alphabet, while the interest that pervades the natural history of vegetation, and its wonderous phenomena, are consigned to unmerited neglect. The simple acquisition of calling plants by their names, and distinguishing one from another, or even describing them in the barbarous jargon of latinity, so profusely displayed by some that bear the name, and affect the title of eminent botanists, excites our pity and regret for such a useless waste of time and talent; worse than misapplied, as it only serves to perpetuate the alchymy of science, and frighten, if not disgust, those who would otherwise enter upon the study, and pursue it with delight. Nomenclature is very well, and it is necessary; but we look for something more from those who *should* be qualified to give it. The petty details of a Latin description, in all the trifling of contemptible minutiæ, draws a little too much on passive obedience and forbearance, when unaccompanied with a single allusion to its physiology, its use, or adaptation. Is it too much to call these individuals learned and laborious triflers; "pleased with a feather, tickled with a straw?" They obstinately withhold the key of knowledge from the individual who would willingly enter in by the gates of science, and form one at the banquet. Like the cuttle-fish, they render themselves invisible, by an obscurity of their creation, and flounder in darkness. At best they resemble, with their *hortus siccus* in store, a mere collector of butterflies and moths, accompanied with a parade of names; while the possessor still remains like one of the heroes described in Parson's "Booke of Fools." Far different is it with those who wish their fellows to join them, and enjoy the advantages and pleasures of science. Natural history is at the present moment in a most deplorable and repulsive state, from a phalanx of uncouth names, incessantly changing, and changed, by the caprice or whim of the individual who may spend a little more time on any specific subject of enquiry than his predecessor had done: in this way many plants have more than a half-dozen of names, dressed in turgid Greco-Latin. It is indeed desirable that this folly were at an end: I have no doubt numbers, as well as myself, feel the difficulties to be almost insurmountable.

The physiology of vegetation does not stop short with a description of the structure and attire of plants in their visible form and exterior; it investigates, not only their organs, but their functions: it penetrates the history of the life of the plant, in its various evolutions and phenomena, and traces the progress of its annals from that point in its history when it is committed to the earth, under the form of an acorn, until it becomes the hamadryad of the forest,—"the monarch of the woods."

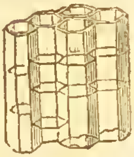
CHAPTER II.

Composition of the Plant—Cellular Tissue—Vessels—Elementary Parts, comprehended under the general terms of Bark, Wood, and Pith.

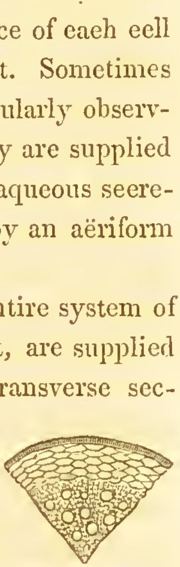
There are two natural divisions in reference to the composition or structure of plants; one of these comprehends the peculiar organs connected with their growth, or successive development, and by which they are supported and preserved; the other embraces that class of organs by which the perpetuity of the plant is secured, and its type transmitted, in a fac simile of the original, from age to age. The cedar of Lebanon is but a scion of that which was first planted by an Almighty hand; and the oak a counterpart of that under which the patriarch reposed on the plains of Mamre.

Vegetable fibres are composed of minute and delicate threads, or filaments; separated only by chemical means, and composing the plexus or net-work of vegetable structures; on the other hand, vegetable *membrane* is a delicate film, which overspreads this fibre. It is the cuticle which forms the vesicle of the cell, or the cellular diaphragm; as well as the epidermis or external veil, or covering, which serves the purpose of a generally investing membrane.

Cellular Tissue is, as its name implies, a structure composed of cells; sometimes hexagonal, as in the figure, which exhibits the cellular structure of the sugar cane, composed of hexagonal cylinders; at other times they are circular, more or less compressed, &c. These cells are of various sizes, in different plants; the diaphragms which separate the cells are double, similar to what we actually meet with in the structure of the cells of the honeycomb, a necessary consequence of each cell being individual, and distinct from the rest. Sometimes these cells are replenished with air, particularly observable in aquatic plants; at other times, they are supplied with liquid matter; and occasionally this aqueous secretion is, in process of time, substituted by an aëriform matter, as in the medulla of the elder.



The cellular apparatus pervades the entire system of the plant: the leaf, the stem, and the root, are supplied with these cells. The figure exhibits a transverse section of the root of the sweet-pea, magnified, wherein the hexagonal cells of the bark are sufficiently apparent, and seem to be flattened by pressure, either from without or within. Among the cryptogamia, we frequently find the vascular structure entirely absent, and the cellular, the almost exclusive form.



The vascular organs are composed of distinct tubes or pipes; hence when a plant is wounded, as in the bleeding vine, the sap distils from the orifices of the tubes, by the section of the vessels. Some of these vessels conduct the sap upwards to the leaves; and others convey downwards the sap from thence, where it has been more fully elaborated: the former series are termed conducting vessels, and the latter returning vessels. These vessels are real organic tubes, are sometimes aggregated in parcels, and occasionally interlace and anatomose, or fall into each other, by the orifices or mouths, which connect them: these vessels exhibit a great variety of modifications; they are *annular, beaded,* or *spiral.* In what is called the skeleton leaf, where the cuticle is removed by maceration, the vascular system is beautifully pourtrayed. Plate II. figure 8, exhibits a skeleton leaf of the *ficus religiosa,* or banian-tree, in my possession, which has been ingeniously made, by means of a transparent varnish, the canvas whereon is depicted a sprig of the tea-tree in flower. I have another skeleton leaf, of the same kind, with a sprig of the yellow Chinese rose painted on its varnished surface.

The bark, wood, and pith, are general terms, comprehending the mechanical structure of the trunk and twig, or branch, the ramification of the stem. The epidermis is a thin film, which covers the bark, and forms a defence from external injury. In the birch, when in an advanced stage of growth, it is white and silvery, easily recognized even at a distance, and thus adds a peculiar feature to the landscape: it peels off readily in thin laminæ. In the aucuba japonica, or gold plant, the epidermis is yellow; it is however generally colourless, and occasionally transparent. In leaves, the epidermis possesses a reticular or net like structure, and the meshes of the tissue vary in different plants, but are fringed at the edge by spiral vessels. In reeds and grasses it contains much finely divided silicious matter; hence two portions of ratan cane emit sparks by collision ; and the equisetum hiemale is used to polish wood, and employed by the Swiss, among the vallies of Switzerland, &c., as a substitute for sand-paper, in their beautiful models of Swiss cottages and dairies. A stem of barley may be fused into a transparent globule, and lightning has converted the hay-rick into a vitreous mass. The equisetum has been used to give a keen edge to the razor; and the Dutch reed in polishing, derives its efficiency from the same source; also the teazle, dipsacus fulonum, employed by the clothier to raise a regular pile or nap on the surface of the cloth. Mr. Knight sharpens razors from the ashes of the *Elymus arenarius,* and other marsh grasses; also the ashes of wheat. Stedman mentions, that there is in Surinam a species of grass, the edge of which cuts, like a razor, the legs of those who pass through it: the edges of the *Scleria grandis* are as sharp as glass. No doubt tropical forests and jungles are often set on fire, by the collision of the silicious matter of the ratan and other canes, when shaken with the wind. The epidermis clothes the most delicate petals of the flower, as well as the foliage, the stem, and the root. It seems to be altogether distinct and peculiar, is pervious to light, and is at the same time an absorbent and exhalent membrane, as well in its relations to moisture as to gaseous media. It is probable that these composite functions are connected with the presence and absence of light, and increase or decrease of temperature: with both of these electricity is connected.

The bark, properly so called, includes the *cutis*, which comprises two distinct membranes, the external epidermis, already described, and another layer immediately beneath it, which appears to be composed of a plexus of transverse cells, having their orifices on the surface: the green matter, beneath these folds, is not however intercepted by them. They cover the cellular integument, composed of hexagonal or six-sided cells, having a vertical arrangement, and possessed of varied regularity. This cellular tissue is replenished with a green coloured fluid, imparting its refreshing tint to the leaf and stem. The colour is not invariably green, though it is the most generally characteristic tint, as in the foliage of the forest, or the carpet of the field; for instance, the *tricolor*, which displays three distinct colours on its leaves, and the trifolium incarnatum affords a similar digression from the usual livery of leaves. The castilleja coccinea, or vermillion-leafed castilleja, displays scarlet bracteæ, and those of the hortensia are sometimes blue. The leaves of the aucuba japonica are sprinkled with yellow dots: the purple beech, and a variety of others, will also present themselves to the mind as interesting exceptions. The term anomally we would willingly discard, there is no such thing in the volume of creation: it is employed by man in the pride of human intellect, too dishonest to confess his ignorance, and acknowledge that he sees but in part.

The *liber,* or inner bark, possesses a distinct fibrous texture, composed of bundles of longitudinal fibres; not altogether parallel, but somewhat curved, and having the intervening spaces filled up with cellular matter. The cortical fibres appear to be hollow tubes, through which the *cambium,* or sap, after it has been elaborated in the leaves, descends, and thus permeates them. When the liber of the daphne lagetto, or lace-bark tree, a native of tropical countries, is soaked in water, and beaten, it may, by lateral extension, be formed into a beautiful gauze, and is worn in some countries as an ornament of dress; when bleached it is extremely beautiful, and fine specimens might be brought into competition with those of lace; we possess a specimen more than a yard square. It is this which imparts a fibrous consistency to the bark of the paper mulberry, made available in the South Sea Islands as articles of dress. Hemp and flax yield familiar examples of the cohesive fibre of the inner bark, and also the common bramble, which I have found so strong as to serve for cordage; the phormium tenax or New Zealand flax, is an additional example of precisely the same kind. From the liber, or inner bark of the white mulberry, (morus alba) I obtained a small specimen of the most beautiful white silken fibres, resembling China silk. Oak bark, which has been long exposed to the storm, and weather-beaten, exhibits a reticular structure, not much unlike that of the daphne lagetto. Duhamel made an experiment which clearly proves that the inner bark is pushed forward *a tergo,* as the physiologist terms it; for, by passing a silver wire through the *liber,* it was found some years afterwards in the external decayed bark. It does not appear that the bark is supplied with spiral, or annular vessels; but the cells being furnished with elaborated sap, descending from the leaves, impart their respective virtues to different barks, as medicinal properties to Peruvian and augustura barks; its astringency to that of the oak, and its antispasmodic, &c., character to the cinnamon.

The wood reposes immediately under the bark, and forms the skeleton or framework of the plant: its form may be said to be moulded on it, and its consistency and symmetry depend upon it. The wonderwort, or *thaumasia ovalis,* a native of Ceylon, possesses a very remarkable structure; it appears to belong to the zoophytes, by virtue of its skeleton, formed of meshes of hard threads, like a hog's bristle, which are solid, fragile, and rigid; the investing membrane however, which connects the wonderwort with the flags or algæ, is thin, flexible, and leafy. In that singular aquatic plant, the *hydrogeton fenestralis,* a native of Madagascar, the longitudinal fasciculi, which compose the leaves, are united by transverse bands, forming square meshes, perfectly open, resembling skeleton leaves, and having the appearance of wire gauze: the wood is composed of numerous concentric cylinders, overlaying each other; these ligneous cylinders become more and more solid as they approach toward the centre: the cylindrical envelope, immediately under the bark, is more succulent, or much less compact, firm, and dense, than the rest, because it is the last formed: it receives the name of *alburnum,* or young wood: the ligneous cylinder nearest the centre is called *heart-wood,* it is the most substantial and durable, being more mature, and more completely indurated: these cylinders of wood will be discovered to be traversed by radiated lines, converging toward the centre; and composed of longitudinal vessels, aggregated or bundled together in fasciculi, or parcels: these radiated tracheæ of the wood, the lymphatic tubes of Decandole, and false tracheæ of Mirbel, are commonly called medullary rays, though altogether unconnected with the medulla or pith. See plate II. fig. 10, for a representation of the medullary radii traversed by concentric layers. The vessels of these concentric layers exhibit various structures, being beaded, reticular, &c. In the layer immediately concentric with the medulla, they are composed of spiral vessels coiled up, reposing in a compressed form. These last are easily recognized by twitching asunder the leaf stalk or petiolus of the elder, in early spring; when, with proper care, they may be extended nearly an inch, without breaking; but I have found the most striking example of this kind in the leaf stalk of the cyamus nelumbo, a stove plant; the lotus of India, and sacred bean of Egypt: these spiral threads we have drawn out to more than a foot in length: the medullary rays, particularly obvious in a transverse section of the root of the carrot, proceed from the concentric cylinder of wood, which immediately surrounds the one enclosing the pith; though that nearest the medulla be devoid of them; and traverse, in diverging lines, the wood terminating in contact with the liber or inner bark. The concentric cylinder of wood, forming as it were a sheathe for the pith, which occupies the centre, differs in its organized structure materially from those superimposed upon it. It is composed of small oblong cells, which enclose a circle of spiral vessels, of a simple character, while a sheathe or membrane interposes its fold between the pith and these vessels.

The medulla, or pith, fills up the centre, surrounded by the cylindrical tissues of wood and bark: sometimes the medulla is found firm and full of sap, but in process of time, when the plant becomes more mature, its character is essentially changed; it is then dry, light, and full of air cavities. This cellular tissue, charged in the first instance with aqueous juices, exchanges its contents for aërial matter: cells often present, in their structure, the form of regular hexagons: the pith is generally white, though sometimes coloured; it is yellow in the barberry; fawn-coloured in the sumack; and pale brown in the walnut. Sometimes the pith is separated at intervals, transversely, with partitions, or diaphragms; of which the walking cane, as well as the *saccharum officinarum*, or sugar cane, supply examples. The diameter of the pith remains generally unaltered, though the sun-flower affords an evidence of a change of structure: the central space, which includes the pith, though usually circular, is sometimes discovered of different geometric forms. From the pith of the elder, or that of the great American aloe, are made the balls and figures used in electrical experiments; and in Portugal, and other countries, the latter affords materials for various toys. In the sübstance, called *rice paper,* a distinct cellular structure may be easily discovered, in translucent specimens; and it has been supposed to be obtained from the pith of the *artocarpus incissifolia,* or bread fruit tree, but this does not appear to be the case: rice paper is made from the pith of the *calamus petræus,* called by the Chinese Tong-t-sao: it is brought by them in their junks from the island of Formosa: the sheets äre usually made up into parcels of about twenty pieces each. Having been soaked in water, the vegetable material, which yields the rice paper, is sliced down with a sharp knife from circumference to centre, then spread out, and submitted to pressure: the refuse pieces are employed to make artificial flowers, and I have specimens, ten inches by six, containing native sketches of Chinese costumes, landscapes, &c., with some beautiful flowers, painted with rare fidelity; and the *bombax insigne,* figured in Dr. Wallich's splendid work, the "Plantæ raroies Asiaticæ," is among them. This substance is much used for ornamental purposes, as in artificial *bouquets,* and paintings of flowers, insects, and birds. The foliage and floral wreathes, which decorate the delicate biscuit porcelain vases, in chimney ornaments, are formed of rice paper: the specimens usually met with do not exceed three or four inches square.

I have seen a specimen of the pith of the *calamus petræus* in the museum of the Bristol Philosophical Institution, and by a tolerably close comparison with specimens of rice paper, I should pronounce them identical: the specimen referred to had a circular hole in the centre.

From the *pith* of the papyrus antiquorum, were formed the papyri of Egypt, found in the sycamore (ficus fatua) coffins, the dormitories of mummies; as well as those recovered from the ruins of Pompeii and Herculaneum. The "paper reeds by the brooks," are mentioned in the prophetic records, several centuries before our æra: the papyrus still clings to such spots among the marshes of Egypt, and the Delta of the Nile; and forms a beautiful ornament on the banks of the Anapus: that found among the swamps, near the ancient Syracuse, seems to be a variety, if not a distinct species; and M. Lippi states his having found two species different from the true papyrus antiquorum of modern botanists. The cyperus papyrus of Linneus rarely exceeds ten feet in length, which is about that of a specimen in my possession, though Pliny says the root was as thick as a man's arm, and that the plaut occasionally exceeded fifteen feet in height. Its stem is imbricated, of a triangular shape, and tapers toward the summit. The head of the papyrus is composed of a tuft of small grassy filaments, about twelve inches long; toward the middle, each filament separates into four, and in the partition are four branches of flowers, not unlike an ear of wheat, but forming a soft and silky husk. The flower of the papyrus was used in ancient times in religious ceremonies. We have seen a very fine and tall specimen of the papyrus antiquorum in the lecture room of the

Botanic Garden of Edinburgh, growing in a vessel of water. This celebrated plant supplied the paper or writing material of ancient times; and, in the natural history of Pliny, we are supplied with a description of the process employed for making paper: the papyrus was separated into thin slices, by a fine point; these were brought into contact by their edges, transverse slips were again superposited on them, with their edges in similar contact: this done, the mass was sprinkled with Nile water, and submitted to pressure. This ancient paper, which became an important branch of Egyptian commerce, especially with the Roman Empire, and in the reign of Augustus, we have every reason to believe was thus formed. If we hold up a specimen of Egyptian papyrus, between the eye and the light, the ribs may be seen parallel, and crossing each other at right angles. We have seen two specimens of modern papyri, manufactured by the Chevalier Landolina, of Syracuse, by a process similar to that described by Pliny, in which the medulla, or pith, was employed, *not* the external rhind of the reed, as has been generally supposed. One of these specimens I saw at the Studio of Naples; the other in the British Museum, with a description of the process in Italian, both presented by Landolina. I have compared each of these with Egyptian papyri, also with those recovered from Herculaneum, and there can be no doubt that the process employed has been the same. Dr. Schouw, of Copenhagen, supplied me with a detail of the process communicated to him personally by Landolina, and it is substantially what has been stated. I have myself tried the same experiment successfully, on a small scale. The paper formed from the paper reed was in high estimation in the time of Alexander the Great. Ptolomy Philadelphus, King of Egypt, when he commenced his library, and collected an immense variety of books, had them copied on this kind of paper. In his reign, considerable quantities of the paper were exported; which was, at length, however, prohibited, to prevent the King of Pergamus from establishing a rival library. Paper made from the papyrus, was principally manufactured at Alexandria, and the city was considerably enriched by the exportation of this paper. Vopiscus mentions one Fermies, who boasted that he could maintain an army from the value of his stock of paper: when it began to be disused is not certainly known; as late as the fifth century it was in general use in Europe; and in Italy and France, was continued to the eleventh and twelfth centuries.

In this curious enquiry, however, we must not confound the *Cyperus Niloticus,*—the BULRUSH of the sacred volume. It will be remembered that the infant legislator of the Jews was exposed to the mercy of the waters of the Nile,—the "Father of Rivers," in an ark, or small boat formed of this kind of reed. There can be little doubt that the hawk-headed infant, confined in such a boat, or ark, discovered among the hieroglyphics in the tombs of the kings, by Belzoni, is intended to adumbrate this interesting event in the history of the Pharoahs of Egypt. In the book of the Prophet Isaiah we read of " vessels of bulrushes, on the waters." On referring to these curious symbols of aboriginal Egypt, we find that the boat *Baris* is evidently thus constructed; one of these, which I have seen depicted on a mummy case, is of a very graceful shape, terminating in the flower of the lotus, with a beautiful curve inwards, and somewhat resembling in lightness and elegance of form the Venetian gondola. In plate II. figure 12, is a bark copied from the celebrated mosaic of Preneste, and claiming an undoubted antiquity of more than two thousand years. There can be no doubt that the boats of ancient Egypt were constructed of the cyperus niloticus: Pliny expressly states this fact; and according to his account of the matter, the reeds were collected, stem and stern being sewed together, and made fast to the keel;

> " Conseritur bibula Memphilis cymba papyro."

According to Theophrastus of Eresus, not only were boats constructed of this plant in Egypt, but sails and cordage were formed of the rhind. Pliny, as has already been remarked, adverts to the paper boat among the equipments for navigating the Nile; also mentions that the cordage and sails were composed of its bark. Herodotus describes the Egyptian manner of ship-building; planks were cut from the thorn tree, (in all probability the acacia nilotica), these were employed in pieces of two cubits in size, round long thick stakes, put together as in building with bricks, transverse beams were then placed on them, filling up the joints in the inside with papyrus; a rudder passed through the keel; the mast was formed of the thorn tree, and the sails constructed of the paper reed. Mr. Bruce says that the only boat they have in Abyssinia is formed of this reed, attached to a piece of acacia as a keel, the reeds being sewed, and gathered together stem and stern. This has also been verified to me, by Earl Mountnorris, who further added that these Abyssinian vessels were pitched within and without with bitumen. Rude boats of this description are still employed on the Nile, in Nubia; and on the Tigris and Euphrates. To this part of the plant, Linneus assigned important functions, assimilating it to the brain and nerves of animals. It seems however to be more analogous to the cancelli, or lattice-work, of the bone.

From the pith of the cycas revoluta, and other palms, is made the sago of commerce; the pith of the trunk of one species of palm has been calculated to yield about 600 pounds weight of sago. Bundles of the rice paper plant, which, according to Major-general Hardwicke, grows abundantly not only in China but in the marshy plains, and on the borders of lakes in the provinces of Bengal, are bound together in lengths of about three feet, and form floats for the fisherman, who with one of these under his arm, walks into the deepest waters and spreads his net, without a boat. I am informed by a gentleman who has been sometime in China, that the Chinese make a quadrangle of four canes tied together at the angles, and thus form a completely buoyant support for the body, preserving it erect in the water. From some interesting experiments which I have made with the *Elder*, I feel firmly persuaded that a fascies or bundle of the dried stems of recent growth, in lengths of a few feet, would form admirable floats, and make life-buoys or life-preservers at little or no expense; at most, a few pence each faciculus. Skins inflated with air might be punctured by the point of a nail or the angle or edge of a rock; but in this case, all such danger is obviated: for further security a covering of caoutchouc cloth might be added, though almost superfluous. In the case of accidents, from the breaking of ice, such inexpensive auxiliaries might be easily available. The Indians make rice paper into hats, which must be of the lightness of gossamer.

CHAPTER III.

The Root—Its Structure and Phenomena—Functions of the Root.

THE root has a twofold character: it serves as the anchorage of the plant, by attaching it to the soil; the fibres, moreover, are capillary tubes, by which the plant is sustained, as they are the canals which absorb nutriment; they may therefore be considered as the tentacula of the plant. The root penetrates sometimes to an immense depth, at other times it is more superficial: its ramifications, in many instances, extend far and wide, especially in such trees as have a diffuse canopy, as in the cedar of Lebanon. In some plants, this organ appears to be entirely absent, and its functions are supplied by other means; for instance, the nostocs, or fallen-stars, palmella cruenta, or gory dew; protococcus nivalis, or crimson snow; hœmatococcus sanguineus, or blood stain, and lepraria kermesina, or bloody rain, which have excited the wonder, and roused the superstitious fears and terrors of the ignorant in every age. The epiphytes, called aërial flags, or lichens, afford familiar examples of rootless plants, they are superficial, and often decorate the otherwise barren rock with varied colours, picturesque and beautiful;—all the geography of isthmus and isle; sometimes bearing also a striking resemblance to Hebrew and Chinese characters; and when rightly interpreted, it appears, some of these interesting epiphytes are legends which not only distinguish various barks from each other, and enable us to discriminate the genuine Peruvian bark, but their comparative officinal value.

Roots are distinguished by a diversity of forms, as the fibrous, spindle-shaped, bulbous, and tuberous; to these may be added the creeping root. The fibrous root is exemplified in the rose, gooseberry, and apple; the spindle-shaped root, is illustrated in the mandrake, carrot, and red beet; the bulbous, in the onion, the lily, and the tulip; and the tuberous, in the potatoe, the yam, and the Jerusalem artichoke. The creeping root penetrates the soil horizontally, and pushes forth stems which emerge above ground. Mint for instance, and that plague of gardening and gardeners, the couch or squitch-grass. The "fiorin grass," found among bogs, and once recommended for pasturage, and cultivation, in such situations, exemplify the creeping root.

Modifications are found in these forms of roots; the *scabiosa succisa,* and primrose, have semi-fusiform or spindle roots, as if they were abruptly terminated, or broken off. To these might be added the turnip, European cyclamen, and others, as additional changes of form, or varieties in the root, allied to tubers, or connecting the tuberous with the bulbous root. The most famed root in the annals of legendary superstition is the mandrake, (atropa mandragora); it is a forked or divided root, and was fabled to utter a groan on being torn from the earth, accompanied by madness or death to the unfortunate listener: it was dragged from the earth by dogs,

> " —— Torn out of the earth,
> That living mortals hearing them, run mad."

Endowed in the manner of the far famed alkahest, these roots were a species of catholicon, and like the diamond of the Rajah of Mattan, not only cured diseases, but preserved from misfortunes. Fictitious mandrakes were formed of some fresh root: this was moulded by art into an anthropomorphous shape; grains of millet seed were imbedded here and there into the root, which was then buried in sand, where the seeds germinated, and the fibres served, when arranged, as an ornament of hair. These artificial mandrakes were sometimes sold to the credulous at an enormous rate: at Rome even as high as thirty pieces of gold each.

The tuberous or knobbed root, though sometimes single, is also found in bunches variously connected. The tubers of the potatoe are attached by threads: sometimes the tubers are threaded like beads on a string, as in the fillipendula. In some grasses, a series of ovate tuberous bulbs may be found, built as it were on each other, without any connecting isthmus: the white saxifrage exhibits bunches of such tuberous bulbs, sprinkled here and there on the line of the fibres, like so many ganglia on that of the nerves. The twin root has been already adverted to, in the orchis; in the dahlia, and the peony, the tubers hang in bunches. Tubers sometimes make their appearance on the axillæ of the stem, as in the potatoe.

In bulbous roots, there are several varieties. The bulb is solid in the crocus; tunicated in the onion; and composed of scales in the lily. The increase of bulbous offsets is found to be in most cases at the base of the parent bulb, as in the white lily, and that called the ‘ potatoe onion:’ sometimes small bulbs make their appearance on the parent stem, as in the tiger lily; an admirable source of their numerical increase, and from which I have obtained nearly 1,500 specimens of that gaudy flower, which grow with me to an altitude of nearly six feet. Sometimes there appears a bunch of bulbs at the summit of the stem, as in the ‘ tree onion.’

The root will be found, frequently, to modify itself according to circumstances. In a loose and sandy soil, the roots will ramify into minute threads, and so become a soft down; this is shewn in transferring a tuft of grass, to a sandy soil; and when carrots, parsnips, and liquorice roots are preserved in sand, they become bristled over with these delicate filaments. The *Phleum pratense* becomes, in a fluctuating soil, the phleum nodosum of some authors; but in a damp soil it is entirely fibrous, and luxuriant. Sir J. E. Smith found the alopecurus geniculatus, a root which is naturally fibrous and creeping, supplied with an ovate juicy bulb on the top of a dry wall: this seems to me curiously elucidated by a singular phenomenon in some potatoes, shewn to me by Luke Howard, Esq., Ackworth Villa; with a correct drawing of one of these I was favoured, as represented in plate I. figure 6. These tubers had been preserved from the preceding year, and placed on a rafter in a cowhouse, where, of course, the temperature was generally above that of the external ambient atmosphere. These tubers pushed forth a number of singular excrescences in the form of bulbs, of a turnip-shape, somewhat similar to those we find occasionally on the potatoe stem. The root of the crocus, after making provision for its perpetuity by an offset-bulb, perishes. Precisely the same thing occurs in that curious class of flowers—the orchises. Sometimes the tubers attached to a single plant amount to three, such as the orchis acuminata: the full tuber is the immediate production of the year; the shrivelled tuber is that expended in the inflorescence of the last year, and the skeleton that of the preceding season. When a double tuber was separated, and the single tubers thus detached, were cast into water, the first sank from its greater density, and the other floated: this last was worn round the neck as a magical incantation, to secure attachment. In the case of the orchis, just mentioned, there are two tubers, and as the one decays another springs up in an opposite direction; the original situation of the plant is thus constantly changing, and it would, if permitted, in process of time make the pilgrimage of the garden; so far it is locomotive. A similar phenomenon occurs in the iris, &c. The march of the monkshood will be about an inch annually, or nearly eight feet and a half in a century.

Some plants seem to be altogether composed of root; for example, the truffle, or tuber cibarium, the subterranean abode of which is traced by pigs and dogs, trained for this purpose in Italy and elsewhere. There appears to be a subterranean tuber in Van Dieman's Land, which has been thus described: it is found at the depth of 12 to 18 inches in the earth, appears to be somewhat rounded, and about the size of a man's head: the skin of the tuber is thin: it is called *Indigenous Bread.* It is spongy, nutritive, and possesses no fibres. Its presence under ground is indicated by an exceedingly minute leaf above ground, attached to the tuber by delicate strings, which break when raised. This nondescript appears to be below ground what the rafflesia is above, and is likely a species of edible fungus. Strictly speaking, the bulb is not a root, it is rather the reservoir, where are treasured up the various rudiments of stem, leaf, and flower; to be unfolded in due time; in fact, the bulb is the hybernaculum, or winter house, where are folded up the hope and promise of the year. The individual buds on the stem and branches of a tree, are the veiled places of repose for the leaves and flowers, or an offset branch: they are scattered over a large surface, while in the bulb, the whole, including stem and branch, are collected and shut up: the small bunch or knot of filaments which is affixed to the base of the bulb, is therefore more properly the root, if the root is to be considered as the conduit pipe which convey nourishment to the plant, and sustain it in the earth; for many bulbs are entirely above ground.

Though the root usually springs from the base of the tree, the branches sometimes detach roots; of this description is the tree houseleek, sempervivum arboreum, found attached to rocks on the shores of the Mediterranean—(See plate II. fig. 9,)—the branches bending downwards, detach parcels of fibrous roots at the bend. The celebrated banian tree, or *ficus religiosa,* of which that of the Nerbuddah is a spacious example, projects roots downwards from its branches; these, fixed in the earth, become stems, and form a "pillar'd shade."* Though there have been miniature specimens of this tree in our conservatories, the fixation of the detached roots had not been accomplished, until the precaution of enclosing them in tin tubes was adopted; this gave them a direction, and likely preserves that hygrometric state which is essential to success; so that perhaps a band of moss, such as was employed in the case of the scarlet air plant, would have equally subserved the purpose. The *pothos violacea,* so called from the colour of its berries, is a native of Jamaica, and a shrubby stove plant. Its stem supplies roots similar to the banian tree. The mangrove, of which more in the sequel, is a most grotesque and extraordinary instance of a similar nature; the lower series of branches bend to the ground, take root, and form a series of arcades; so that the tree seems lifted up into the air, and supported between the heavens and the earth, by gigantic stakes. These illustrate the conversion, or change of the main roots into stems, and *vice versa.* There is a plane (acer pseudo-platanus) among the ruins of New-Abbey, a monastery in Gallowayshire; it once overtopped the wall, but being incommoded for want of room or food, detached a strong root from the top of the wall, which established itself in the soil below, was changed into a stem; and having disentangled its remaining roots from the top of the ruin, the entire tree became insulated from, and independent of the wall. The tree thus walked from its original scite. Lord Kaimes mentions the phenomenon, and the fact is well accredited. A strawberry, planted in the angle of a garden, in a poor and sandy soil, has detached a stem in the direction of the richer soil, fastening its roots in its progress thither; the original stock decayed, and the plant advanced, pas à pas, progressively to the genial earth. On the Lago di Como, near to the Villa Pliniana, we have observed pendant roots, that had crept down the surface of the rock and become stems.

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* Plate I. Figure 1.

Some leaves will strike roots, of which the bryophylum calycinum, exhibits a curious instance; each serrature of the leaf giving rise to a young plant with perfect leaves and roots; and I may mention as a curious instance of the vitality of this leaf, that I put one between two folds of blotting paper, and having carelessly put it past, it was overlooked for more than a twelve month: when it was accidentally discovered, the entire edge of the leaf presented a curious fringe of miniature plants, springing from the several serratures, all in full vegetation and vigour. In the Radick Islands in the Pacific

Ocean, the natives rear the *arum esculentum* by planting the leaves. The gloxinia speciosa, and gesnera bulbosa, will both grow freely from leaves and form bulbs.

The asplenium rhizophyllum pushes forth a tuft of roots at the tips of its fronds, and these bending to the earth strike root and form so many loops.

It should be observed that individual scales, after their detachment from the bulb, will push out small bulbs and roots; for instance, the scarlet pompone and superb lilies. I have succeeded with those of the white lily, and believe the scales of the root of the zamia horrida have been found to germinate. In Denon's Travels there is an account of a tamarix which had been overwhelmed, and the fibres of the root becoming erect, produced leaves. The willow has been reversed, its head and branches being buried, and its roots waving in the air, when the latter were in process of time converted into branches and leaves: a similar experiment has been successfully made with the plum and the cherry. No doubt that peculiar phenomenon we meet with among some of the vallies of Switzerland, is ascribable to a cause similar to that mentioned by Denon, in reference to the tamarix: willows having been overthrown and buried, by the alluvium washed down from the sides of the valley, the root fibres struggling through the superincumbent soil, instead of being directed downwards, become miniature stems clothed with leaves, and so multiply as to put on the singular appearance of that called the *saule-en-herbe,* or willow grass, which forms a carpet for the valley.

Roots, though sometimes acrid, frequently supply much wholesome nutriment, chiefly fecula: the potatoe,* the yam, the Indian arrow-root (maranta arundinacea), the orchis morio, the source from whence salep is obtained, the Jerusalem artichoke, and others, shew the economical importance of many of the tuberous rooted plants. The *arum campanulatum,* represented in Plate I. figure 4, is cultivated for its root in the East, as the yam is in the West Indies. Nor are bulbous roots without their importance; in the East Indies, as well as Egypt, the onion is prized, and we have been informed by a military officer, sometime in Egypt, that this root is very superior in taste and flavour to those cultivated in Europe; it is highly relished, and still bears as great repute now, as when it formed an item in the reminiscences of the children of Israel. The Kamtschatka lily supplies the Kamtschatkans with their best bread. The tulip root is eaten in Italy, and some of the ornithogalums and ixias become food in Africa: no doubt a variety of others, in times of scarcity, might become wholesome articles of diet, and some, perhaps, items of luxury. The crocus root seems to be a great favourite with mice, and this season, I have lost nearly a thousand crocus bulbs, by their destructive ravages.

The root may be considered as compounded of several parts: its stem or main trunk, and its lateral rootlets or fibrils: these last may be subdivided into two parts; the filaments or stems of the fibrils which frequently bristle the main root, and ramify in every direction; and the sponglets which terminate the fibrils, and appear to be, when magnified, oblong oval spongy structures, composed of cells. The sponglets contain numerous orifices or stomata, by which the liquid medium, and its soluble materials, enters the vegetable system, on the principles of capillary attraction, as water is absorbed by a portion of sugar, or a bit of sponge. These fibrils seem thus to act in the character of feeders to the main stem or body (caudex) of the root; which, like the river, supplied by its lateral tributary streams, seems to be the main channel or reservoir, from whence the accessory nutriment ascends through the stem, or trunk; neither is it at all improbable that the nutriment thus collected by the tentacular fibrils, if the expression be permitted, may be partially eliminated in the main body of the root, before it rises in the stem: nor is this supposition altogether unsupported, when we consider the diversity of properties, dietetic and medicinal, &c., found in the roots of plants. The spongioles or sponglets, which terminate the fibrils, are obvious enough in the water-star grass; even in the roots of the hyacinth, (hyacinthus orientalis), grown in bulb glasses, the sponglets may be discerned. The fibrils spring from the bark of the root, as may be ascertained in the case of laying carnations, and, especially, in the Chinese method of propagating fruit trees, which we observed to be employed with singular success in reference to the lemon and the orange trees, in Italy.

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* Sir John Sinclair, Bart. gave me a biscuit made from potatoe flour, which could not be discriminated from fine white biscuit made from wheaten flour.

It has been hitherto supposed that the root, and its attachments, act exclusively as absorbents, by imbibing the materials of nutriment from the soil; we are of opinion, however, that they do more than this: in a variety of experiments made with the hyacinth reared in a bulb glass, and supplied with distilled water, I constantly found that the water, in which the fibrils were extended, became soon impregnated with carbonic acid gas, when excluded from all external sources of its production; and by the addition of a little lime water, in the first instance, I had sometimes an interesting deposition on the sides of the glass, of minute rhomboidal crystals of transparent carbonate of lime. It seems to me, therefore, that the functions of the root are twofold, and composed of two classes of organs; one of which are absorbents, and the other act as excretory vessels: the former appear to be resident in the sponglets, and the latter may be connected with the cortical pores. Some experiments of Amici of Modena, seem to corroborate this view of it; and it is worthy of remark, as connected with this question, that coloured fluids, which find an easy ingress through the sponglets, will not pass through the cortical orifices: unless this be granted, the circuit of the circulation of the sap cannot be completed, but on this supposition, the orbit is entire. The superfluous egesta cannot be evolved in a sufficient ratio by the foliage; and, that excess there must occasionally be, from an unsual richness of the soil, cannot be reasonably doubted. During the presence of the sunbeam, leaves cast off oxygene, while the carbon of the carbonic acid gas, is appropriated and assimilated; but, it is by no means probable that the entire quantity of the carbonic acid gas, which rises in the stem, during the day, can be constantly decomposed amidst the varied changes of light and shade; to make no mention of the liquid matter which has been absorbed. I do not for an instant deny, that one series of the functions of the root is engaged, in the vegetable machine, in the capacity of absorbents, for of this I have had the clearest experimental evidence; all that I mean to say is, that there are distinct and peculiar vessels that act as excretory ducts.

During the winter of 1825, I made a series of curious experiments on the functions of the root. Cress was sowed on thin sections of sponge, and when grown about three inches, these were divided into portions; and to the distilled water in the shallow dishes which contained them, as so many distinct tufts, were added solutions of arseniate of potassa, sulphate of copper, sulphate of iron, acetate of lead, and muriate of mercury. All of these vegetable tufts died at different periods, some in a few hours, and others in a few days; and by a careful analysis of their stems, I found decided evidence that *all* had been absorbed by the roots, and carried into the stems. When I macerated for instance the cress, cut above the surface of the sponge, supplied with solution of acetate of lead, and added, as a test, hydriodate of potassa, there appeared brilliant yellow threads occupying the central portion of the individual stem: an account of these experiments in detail, was transmitted to the Wernerian Society: I must therefore confess my astonishment to find that in the *Bulletin universelle des Sciences*, M. Weigmann, after stating that I had denied the power of absorption to the roots, sets about describing a series of experiments to prove, what I had proved already, and published some years before. The circumstance seems to me altogether unaccountable, except on the principle of some mistake in the translation, which though it has certainly entailed on M. Weigmann useless and unnecessary trouble, can in no way affect me; and I am not responsible for the mistakes of others. If we understand him aright, however, he seems to have proved, as I had done in 1818, by the hyacinth, that carbonic acid gas is given off by the roots: at least we apprehend that he means so, in the case of the willow.

The power of the vegetating root is sometimes astonishing, it will grasp pebbles, and completely weave a fibrous web round them. M. Pniot had experimentally shewn, that the radicles of seeds, when germinating, were capable of penetrating mercury. A seed of the lathyrus odoratus, (the cotlydons of which do not unfold themselves during the act of germination,) was placed, one-fifth of an inch from the metallic surface, previously moistened; germination took place, and when the radicle reached the mercury, it pierced, and buried itself within its substance. Dr. Butler, of Shrewsbury, informed me that he had supplied a number of peach and nectarine trees, trained to a wall, with a quantity of bones, by way of manure: some years afterwards, he had occasion to remove the wall, and when the fruit trees were taken up, the roots were found completely investing the bones, and in numerous instances the tips of the roots adhered, like so many suckers, to the surface of these bones, the tips being flattened in contact with the bone. The root of the couch, or squitch-grass, will pass through the solid tuber of a potatoe; but I am not acquainted with a more extraordinary instance of the force of vegetation, in reference to the couch-grass, than the following:—In taking up last November, some bulbs of the tyger lily, I found two of them completely threaded by the repent root of this grass; so that the bulbs, were moniliform, or like beads on a string. The roots of the laurel will overturn a wall, and in Needwood Forest, I have seen the holly luxuriant on the summit of a venerable oak, its roots having cleft and penetrated the stately trunk—and, in Alpine regions, the calcareous and gigantic rock has been rent in twain, by the penetrating root as by a wedge. This tremendous force would no doubt be partly occasioned by the infiltered water, which would follow the root, the rent having been begun, in the first instance, by absorbed moisture, &c.; we have been informed that the root of mint grows much more rapidly during night, than by day; the plant for the experiment was reared in a glass of water.

The spiral vessels, in the amaryllis, and some other bulbs, may be drawn out into threads several inches long; the strength of a twisted thread formed from the spiral filaments of the poison-bulb, Mr. A. T. Thomson found to be considerable, and it appears that spiral vessels of the blood-flower have been spun into thread, and manufactured.

The direction of the root is curious and interesting; it is immaterial how a seed is buried in the earth; the root will invariably go downwards, and the leaf or stem as invariably mount upwards: there is no mistake: the law imposed on vegetation is never violated when free and unrestrained. It seems essential to the proper functions of the root, that it should be hidden from light, it therefore penetrates the earth for concealment. On the other hand, leaves turn their superior surface to the light, and incline in the direction of the sun-beam. Suspended seeds will detach their fibres towards the earth even at the expense of pervading an illuminated medium, between them and the surface of the ground; as proved experimentally by Grew, and corroborated by Dutrochet. Germinating seeds placed on a revolving wheel, direct their fibres toward the periphery of the wheel; as if under the influence of a centrifugal power. This experiment however proves nothing in reference to stationary roots.

The roots of some ferns are not a little curious. The golden polypody, a stove plant, and the hare's-foot fern, from the Canaries, have a singular appearance as they rise above ground: but the tartarian lamb, or *polopodium barometz,* is the most fantastique and remarkable: it is covered with chaffy gold coloured scales, silky and soft. In India it is called golden moss, and employed to stop hœmorrhage. This curious fern is a native of eastern Tartary, and it has some resemblance to a small quadruped, the main tuber rising above ground being supported on four rootlet stems. I have seen a specimen either in the *Jardin des Plantes*, or British museum.

CHAPTER IV.

The Stem—Its Stature and Characteristics—Foliage—Structure and Functions of the Leaf.

Of stems there are various kinds; some appear to consist of a mass of homogeneous consistency, enclosed in a membrane; this will be found the case in the fungi or mushroom tribe. A second class are of a woody structure, composed of fasciculi of vessels distributed throughout a cellular parenchyma, incased in a simple cuticle. The palm, sugar cane, reeds and grasses, illustrate this peculiar class. The third class compose the furniture of our forests in higher latitudes, and have a structure peculiar to themselves; altogether different from the palms and canes. The composition of this last class has been detailed under the terms bark, wood, and pith. We stated that the hardest wood was found toward the centre of the trunk; but it is the reverse with the palms, as well as reeds and grasses, as they are softest toward the centre, and hardest at the exterior.

Many of the tribes of vegetation are without a stem, and it varies exceedingly in stature, in those that have it. Herbs, shrubs, and trees have been a popular distinction in vegetation; but there are *trees* sufficiently diminutive, if a specific stature be the touchstone that degrades them to the rank of shrubs. The *rubus arcticus,* with its root, trunk, leaves, and fruit, would scarcely fill a six ounce phial; and the *salix herbacea,* the only *tree* in Spitzbergen, is so minute that at least half a dozen complete trees including roots, stems, and branches with their leaves, might repose without contact on a duodecimo page. I have nearly twenty of these miniature trees growing, and the entire number, root and branch, would scarcely cover a quarto volume. Yet these curious specimens of creation are even *better* entitled to the name of *trees,* than the towering palm, though they do not amount to the standard commonly assumed as the stature of trees: they are as elaborate however, in their structure, as the most gigantic pine, or baobab.

The palm rises gracefully and erect, and towers to the height of 60 to 180 feet, bearing its royal leafy crown, and in the *Jaqua,* on the Orinoco, carries its clusters of gold and purple berries. The talipot palm affords another instance of the same vegetable grandeur. The stems of palms are quite peculiar; while our forest kings increase the diameter of their trunks with their age and height, the palm remains the same, throughout, from the surface of the earth to the capitol of leaves, which invests this Corinthian column of the vegetable kingdom. One of the palms, the *ptychosperma gracilis,* rises above sixty feet high, with a stem not exceeding four inches in thickness; and the cabbage palm, *areca oleracea,* soars to the height of 180 feet, with a trunk not much thicker. Martius mentions a palm 15 feet high, and not thicker than a man's thumb. Palms, from their singular form, give a peculiar and unique character to the landscape of the tropics.

Other trees have stems, that tower to a vast altitude, but the trunk becomes proportionally gigantic; and in others, the altitude bears no correspondence to the size of the trunk. The pines are magnificent specimens of lofty structures; in the Canadas, and New Zealand, they gain a height of from 2 to 300 feet; and in Australia, is a tree said to be above 400 feet high. The *araucaria excelsa,* or Norfolk Island pine, insinuates its roots into the clefts of the rock, and forms a magnificent plume on the brow of the precipice, 200 feet high; it is a splendid tree. Many years ago, I saw a fine specimen of it at Stowe, in the county of Norfolk. The richest acquisition in this department, which our country has had to boast of, in recent times, is the *pinus douglasii,* discovered by Mr. Douglas on the Columbia River, forming immense forests, some towering in one magnificient cone to the height of 250 feet, with a trunk from 50 to 60 feet in circumference. I saw some healthy and thriving plants a short while ago at Powis Castle; as yet they are choice, but they may add, in future times a magnificence to our woodlands, to which they are yet strangers.

Lewis and Clarke, report that the pines on the Columbia River exceed the height of 300 feet. According to Mr. D. Don, a distinguished botanist, the purple-coned fir of Nepal, found at an elevation of from 8,000 to 10,000 feet above the level of the sea, is a magnificent pine. "This which may be regarded" says Mr. Don, "as the silver fir of Nepal, surpasses all others of the fir tribe in beauty: its lofty and pyramidal form; its numerous long, erect cylindrical purple cones, studded with drops of pellucid resin; and its flat leaves, silvery underneath, and of a bright shining green above, which thickly adorn its ash-coloured branches, render it a truly picturesque object: the trunk is from 70 to 80 feet high, perfectly straight, covered with a somewhat smooth grey bark, and having a circumference of seven or eight cubits."

Not to mention the venerable oaks of huge diameter, in this country, and many of which we have seen; the boabab (*adansonia digitata*) has been found 77 feet in circumference, and even in solitary cases, 100 feet, while the altitude of the stem seldom exceeds 15 feet. The chesnut, on the flanks of Etna, called *castagno di cento cavalli,* measures one hundred and eighty feet, and though now in fragments, it is unquestionable, that these stems were once united. Professor Schouw, of Copenhagen, informed me that he had the question distinctly ascertained, by having the earth removed around it, and found the entire trunks united below ground into one. The dragon-tree at Oratava, in the island of Teneriffe, is 48 feet in circumference. According to Labillardiere the largest cedar on Mount Lebanon is nearly 28 feet circumference. An oriental plane, in the valley of Bajukdere, near Constantinople, has a cavity of 80 feet in circumference. The tree at Huahine, called by the natives *aoa,* described in Bennet and Tyerman's "Voyages and Travels," is probably a mangrove, judging from the description. The girth of the trunk of this cloistered tree, is stated to be 70 feet. The banian of the Nerbuddah, notwithstanding the invasion of the waters on its territories, is still upwards of 2,000 feet in circumference round its principal stems. Some years ago the bole of a large black walnut tree was brought from Lake Erie, in America, to this country, and we believe is still exhibited in London: it measured 36 feet around, and was excavated and furnished as a sitting room.*

The canes and reeds are a distinctly characteristic stem: of these the arundo bamboo is the chief. In Asia it sometimes shoots up to the height of 80 feet in one year. The largest and tallest bamboo in India is said to be 100 feet high. The arundo donax I have seen in the north of Switzerland 14 feet high: these are truly gigantic, compared with the bulrush and reed of our fens and marshes. Indeed, when we consider our comparatively dwarf vegetation in many cases, compared with the splendid vegetation which arrays the regions of the tropics, we may well wonder. The thistles on the interminable plains of the Pampas are 8 to 10 feet high, and above all, the tree-ferns, some of which are said to rise to the height of from 30 to even 80 feet. Their character is somewhat like the graceful dignity of the palm.* The *pteris aculeata* is of considerable thickness, being several feet in circumference. Some American ferns appear as if powdered with metallic dust. Even the eucalyptus of New Holland, grows to the height of 150 feet. Diversified, too, is the apparel of the stem. Branches adorned with foliage of various sizes, shapes, and hues; or tiled with the scales of fallen foliage, as the trunk of the palm. The yucca, aloe, and dracena, though bearing some distant affinity in their structure to the palms, differ from the latter, in not only increasing the magnitude of their stems, but bearing lateral leaves and branches. The cactus tribe are destitute of leaves, though their armature is sometimes sufficiently formidable. The cactus spinossimus is a complete *chevaux de frize,* and as a bulwark might defy attack. In tropical countries they attain the height of more than 30 feet, nor is this so very extraordinary and hard of belief, as I have seen them, though exposed, of majestic stature in the botanic garden at Basle, on the Rhine: there are two in the open ground, in the "garden of simples," at Pisa, upwards of twenty feet high, and I was told they had never been in any way sheltered or protected.

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* A log of wood was cross cut about 14 feet from the root of an elm, which grew in Thryberg Park, near Rotherham: in the centre was a bird's nest with several eggs about the size of those of the chaffinch; the eggs were much discoloured. The girth of the tree was seven feet eight inches; and the nest is still in the possession of Mr. Coulter, of Bennetthorpe. It was surrounded by solid wood without any flaw or rent. I once saw a living scorpion that had been cut out of a log of fustic.

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* A tree-fern was sent some time ago from Australia to a nurseryman at York: when received, it was about six feet high, but seemed dead, and was in consequence cut down: the wood was dense and solid. It has since sprung up, and I believe now succeeds very well.

We have already adverted to upright stems at right angles with the horizon; some stems, however, are slender and twine round supports, in various directions; or remain flat, and incumbent on the plane of the horizon. One of the algæ, the 'everlasting bladder-thread,' has been found by sailors *fifteen hundred feet long*. Mr. Fanning, proprietor as well as curator of the botanic garden of the Carracas, states his having, a few years ago, trained a species of convolvolous no less than *five thousand feet*, in six months; which, had its growth been uniform, was at the rate of twenty-four feet in a day and night.

Innumerable are the various climbing plants that thread and enterlace the interminable forests of tropical countries,

> "Nullius penetrabilis astro."

In the Brazils, the vegetation of which has been so well described by Humboldt, Spix and Martius, and Prince Maximilian; the wild vine, bignonias, passifloras, bauhinias, dendrobias, and banisterias, with countless others, "beyond the power of arithmetic to number up their tribes," wreathe the trunks and branches of these forest kings, with chaplets and garlands of foliage and flowers, not their own; forming a mountainous mass of living luxuriance, adorned with the most glowing colours, as if kindled by the rainbow. Sometimes this forest tackling and cordage, form festoons of flowers, by uniting tree to tree, in a series of natural alcoves, grottos, porticos, and colonades, in all the florid grandeur of the

Gothic architecture of vegetation. "Sometimes straying from their supports," says Viscount Chauteaubriand, "the *lianes* traverse creeks of the rivers, over which they stretch verdant bridges, radiant with flowers: from the bosom of these masses, the magnolia elevates its steady pyramid, surmounted with dazzling white roses, and towers over the forest without a rival, except the palm, which balances near, its fan like leaves."

The forests of the eastern hemisphere have their counterparts in these respects. The *cogue* of Chili, after it has attained the topmost branches of one tree, darts again to the ground, seizes hold of another tree, climbs its summit, and thus passes from tree to tree: it has been known to extend upwards of 600 feet. From its toughness and pliancy it has been employed for cordage and other uses. Colonel Welch describes a phenomenon of this kind in India: "There is," he states, "a creeping plant here, winding itself round several of the largest trees, and in all sorts of fantastic forms; but how it has contrived to throw itself from tree to tree, I cannot possibly conceive. It is generally the thickness of a stout man's arm, and at the base measured fifty inches in circumference. The natives call it *sheekai,* or *cheekay;* the leaves are small and delicate, and the small branches, only, covered with thorns, like fish-hooks. Strange to say, we also found some tall trees of the same species, whilst this one was entirely a creeper." Indeed there can be no doubt but many of these climbing and voluble plants extend *several miles* from their source.

In density or specific gravity, the stems of plants vary materially: some are very pliant, and are gracefully pendant, such as the *casurina,* a leafless plant. The cane is naturally polished and of the hardness of bone; the outer part of the stem of the cocos guineensis resembles whalebone. The axe recoils blunted, from the areca palm, and the sideroxylon, or iron-wood. The lignum vitæ, and other hard woods, seem to approach the adamantine state, and occasionally secrete woodstone; for instance the *tectona grandis.* On the other hand, the wood of what is called the alligator apple-tree is so soft as to be a substitute for cork. The cork, as an external covering for the stem, is a peculiar characteristic in the quercus suber.*

The *cecropia peltata,* or trumpet tree, of Jamaica, attains the altitude of 40 feet: the trunk and branches are *hollow,* supplied with a membranous septum at intervals, like that in the joints of the bamboo. These hollow stems are employed as trumpets, hence the trivial name.

We can form in these latitudes but a faint idea of the magnificence and grandeur of tropical countries: there is a profusion of vitality both in the animal and vegetable kingdom, of which there is no comparative resemblance in our sylvan landscapes: the feathered tenants of our groves, have none of that gaudy and dazzling plumage which bespeaks the tropics; the scarlet ibis, cardinal birds, parrots, humming birds, and birds of paradise, with flammingoes flashing among the lagoons, are associations which give an additional equinoctial character to a vegetation unrivalled in intrinsic majesty and beauty. Sometimes the pendulous blossom imparts an extraordinary feature to these regions; such as the pendant flowers of the boabab, or the banana, and above all the still more singular tree, called *Tabernæmontana alternifolia,* or Eve's apple, of Ceylon. The pendulous clusters of fruit are very remarkable: the fruit is beautiful and tempting, but poisonous: the flowers have a fine smell, and hang in bunches. The figure represents this curious tree after a drawing supplied to Mr. Loudon by Sir Alexander Johnstone. The mahor, or wild cotton-tree, grows in Cuba to a vast size: there is one, on an estate called Santa-Anna, a hundred

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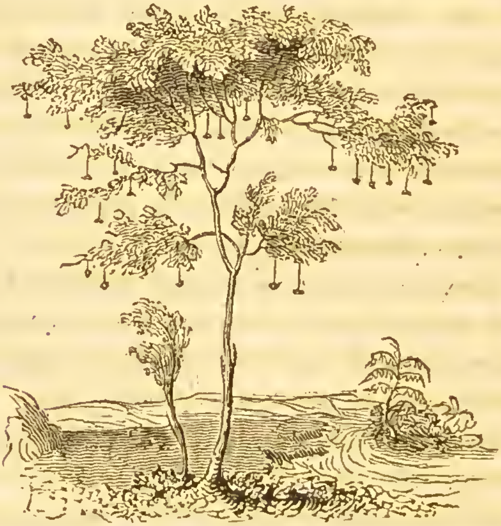
* The bark of the cork tree does not indurate for several years, and care is taken to detach it from the tree before it does so, when it would not be available in the arts.



feet high. Its trunk, which is forty-six and a half in circumference at the base, rises to sixty-five feet, without a single branch or knot on its white bark. The branches cover a diameter of a hundred and sixty-five feet. This immense tree is in itself a world, and shelters and feeds millions of insects. Several parasitical plants attach themselves to it. Wild pine-apples grow at the top, and the vine vegetates on the boughs, and, letting its branches droop to the earth, furnishes rats, mice, and the opposum, which would find it difficult to climb a smooth bark, a ladder, enabling them to reach the pine-cups, which form so many natural reservoirs for the rain-water. The wood-louse founds extensive republics in this tree, and establishes its large and black cities at the junction of some of the branches, whence it descends to the ground by a covered way, which it constructs of mortar, and of which it even provides two—one to ascend, and the other to descend by. Divergent indeed are the extremes in the stems of plants, and remarkable the contrast between that of the *scirpus capillaris,* or club-rush, which is not thicker than a hair, to the gigantic one of the boabab, or calabash tree, whose hollow trunk forms the dwelling-place of several negro families.

That curious plant, called the ROSE OF JERICHO,—the *anastatica hierochuntica,* is a native of the deserts of Arabia, found in the wilderness of the peninsula of Sinai, and the shores of the Red Sea; also the sandy places of Palestine, and Barbary: it does not exceed, inclusive of root, six inches in height. When plucked up, and allowed to dry, its branches curve inwards, toward the centre. It has a very ligneous structure, and hollow cellular knobs adhere here and there, to its branches. Plate I. fig. 7, represents this curious plant drawn from one of the specimens, of which I have several in my cabinet. The late Dr. James Millar had shewn, in a communication to the Philosophical Magazine, that this singular vegetable production will not expand unless the water comes above the *axillæ* of the branches, since the mere immersion of the *stem* will not occasion their evolution. His other remarks merely relate to the quantity of water absorbed in the process. As his specimen was a borrowed one, highly prized, and supposed nearly a century old, Dr. M. did not venture any further experiments, lest the plant might be injured. Being however possessed of a variety of specimens of the rose of Jericho, I made a series of experiments; chiefly in reference to the functions of its stem and branches, as to their absorbent character.

In consequence of shipwreck, one specimen was unfortunately saturated with sea water; and when the packages were opened, it was found to be *completely expanded.* I had it afterwards sufficiently soaked in fresh water, to remove the saline matter; the specimen was not at all injured. When the rose of Jericho was put into water, the lower parts of the branches being immersed, it expanded fully, and closed when a portion of the main stem merely was introduced. In the former case, the interior of the specimen, seemed to remain continually humid. The plant was turned upside down in water, and in this case the tips of the branches being alone immersed, it expanded at the first fork or junction. When it was still more deeply immersed, say to the second series of *axillæ,* the expansion was greater, though the higher portion of the interior remained dry. When entirely immersed in cold fresh water, the expansion was complete. Placed in *boiling water,* so that the lower axillæ were covered, it began to expand immediately, and the progress of the expansion was completely visible, unfolding, apparently as it were, *per saltum,* or in jerks. In this case, a few minutes sufficed for its complete evolution. Many air bubbles invested the stem, exhibiting a kind of effervescence. When withdrawn, it was laid past, but in *six hours* manifested not the slightest tendency to close. It was then entirely plunged into cold water, and had fully expanded in about half an hour : after being withdrawn, it required nearly twenty-four hours to close entirely. The eutire stem, with one-half of the globular head plunged into water, in a glass cylinder, was introduced into the recipient of an air-pump, and the air withdrawn : when the air was suffered to re-enter, no *instantaneous* evolution eusued. The plant *entirely immersed* in water was subsequently placed under the receiver, the air again withdrawn, and subsequently allowed to re-occupy the vessel. This experiment was not followed by any *sudden* expansion, but on being withdrawn, it completely unfolded in a few minutes.

The rose of Jericho introduced by the stem into alcohol, and immersed about an inch above the junction of the lower branches, was entirely expanded in about two hours, when it was withdrawn, and transferred to a heated atmosphere; here the branches began to close almost immediately, and the "rose" shut entirely, as soon as the alcohol had evaporated. The reason why the main stem, merely introduced, does not cause an evolution of the branches is obviously owing to its ligneous texture, and there being no channel of communication, nor orifices, while the branches, on the other hand, possess them.

Foliage is a very common vesture for vegetation, and *green* is the usual colour of the leaf. Leaves are however only a temporary or transient attachment; they, in very numerous cases, unfold in spring, to fade and fall in autumn. In winter, leaves are rolled up in a cerement, which its icy breath cannot penetrate, but as soon as the genial zephyrs of spring play over these buds, the leaves unfurl their beautiful drapery, the meadow and the wood look gay and green again, and gladden and delight: there is something extremely soothing to the contemplative mind, in the garniture of trees: the oaks of Dodona; and the academic groves, where Plato and Socrates reasoned; and Demosthenes and Cicero declaimed. We have still our rows of "reverend elms," and avenues of limes, where learning has its seat,—memorials of classic times. There was a memorable garden on Olivet.

Some plants are evergreen, that is, they are always clothed in leaves, not that these are permanently the same, but there is a constant succession of them, and there being no intermission, they are never leafless: those whose leaves fall in autumn, or whose leaves wither at the approach of winter, are called deciduous; while the others are distinguished by the name of evergreens: the greater part drop their leaves on the ground, but some retain them obstinately, though shrivelled and dried up, until the advance of the buds in spring, "push them from their stools." Even trees of the same family or alliance, vary in this respect; the cypress is evergreen, in many of its types, but there is also a *deciduous* cypress.

There are plants entirely leafless, such as the diversified tribes of cactus, salicornia, stapelia, &c., in which cases, it is not improbable their entire surface supplies the part of foliage.

It has been said that leaves are commonly green, but exceptions to this have been incidentally stated: the arum bicolor, tradescantia discolor, hydysarum pictum, are variously coloured, and of this description is the "ribbon grass," and numerous variegations. According to Humboldt, there is found toward the centre of the *Mauritia aculeata,* a kind of palm, alternate circles, concentric with each other, of blue and yellow; so that it seemed full of eyes like a peacock's tail. Bractæas or floral leaves are, on the other hand, often coloured; instances of this kind have been mentioned; lavender, purple-topped clary, mussænda frondosa, &c., wear coloured bractæas; even the green livery, which might at first sight be supposed monopolized by the leaves, is sometimes found to tinge the flower, though the blossom usually displays the more vivid and gorgeous dyes of the rainbow. The herb true-love, paris quadrifolia, which I have noticed as far north as the fall of Foyers, in Invernesshire, has *green* flowers.

Leaves are simple and compound, and display a remarkable diversity in their form and aspect. To enter on specific details of description, on the various furniture or individual parts of the plant, forms no part of our present design, and the task more properly belongs to the rudiments of technical and practical botany, in its nomenclatural character.

In the foliage of plants, there is a vast diversity in superficial extent, as well as thickness. There are leaves of microscopic minuteness; and others of immense size. Some species of coltsfoot are of considerable magnitude; and leaves of the rheum palmatum, have been found to measure five feet in their longest extent, by three feet in their greatest breadth. These, though remarkable for this climate, sink into insignificance in comparison with tropical foliage; the leaves of the danœa elliptica measure, in many instances, not less than six feet in length, and nearly eighteen inches in diameter in their widest part. The leaves of the strelitzia regina grow to the height of three or four feet by eighteen inches, and sometimes leaves of this plant will be found still larger. The leaf of the musa paradisiaca, or plantain, has been found to measure more than ten feet in length, by two feet at the base. Some leaves of palms far exceed even these dimensions. A leaf of the corypha umbraculifera, or great fan palm, or talipot tree, sometimes measures five and thirty feet in circumference, a sufficient covert for 30 or 40 men. The rafia palm of Madagascar is said to measure sixty feet. A frond of the ciboa-palm serves the natives of Africa as an umbrella, and thus protected Mungo Park from the tropical rains. In the South Sea Islands, the leaf of the talipot palm serves as a parasol, as it does the purpose of an umbrella in the East Indies. At Manilla, one of the Phillipine Islands, a Jesuit missionary had a dwelling constructed for him under two palm leaves, where he said mass, and slept secure; it was a complete covert from the storm, and no rain could penetrate. In consistency also, the fronds or leaves are very various: airy like gossamer, or the texture of the most delicate film, up to the coriaceous mass of the Nopal, or the thick succulent leaves of some mysembranthemums, and the rigid ones of the agave. The leaves of the paliscourea rigida, large, tough, and unyielding, rustle like parchment in the wind; and the cactus spinossimus, and some yuccas and agoves, might form a stoccade or circumvallation, which would defy an enemy, with all the armoury of war. Indeed we once remember to have seen, near to Orbitello, in Italy, a field, of which the agave americana was the entire fence, and a most impenetrable barrier it seemed to be.

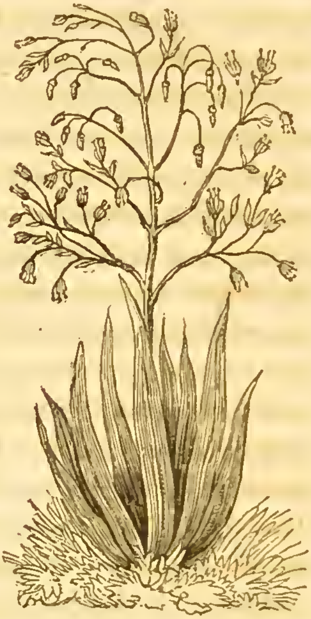
Leaves are sometimes beautifully polished, and shine like ivory, The begonia nitida has leaves which possess a beautiful lustre: the magnolia, the holly, and the laurel have leaves that seem to be varnished. Each leaf of the double-cocoa nut is twenty feet long and ten feet wide. Sometimes the leaf is silky, or satiny, resembling the pericarp of Honesty. The silver tree, protea argentea, presents a beautiful example of a shining satiny leaf: some leaves are so clothed with down as to resemble white velvet: the *verbascum thapsus,* or great mullein, is a familiar instance of a thick woolly covering for the surface of the leaf. Sometimes this satiny or woolly integument may be stripped off entire, a process which is managed with considerable dexterity by the natives of the south of Africa; the stalks and leaves thus treated, supply stockings, gloves, and caps. According to Humboldt, caps are formed of the spathes of certain palms, which possess a coarse net like tissue. The inner bark of cerra duida, or shirt trees, supply the Indians with garments resembling sackcloth.

Though the leaf usually precedes the flower, this is not invariable; the daphne mezereon, and the magnolia conspicua, are striking exceptions to the general rule.

The lower surface of the leaf is not usually varnished or polished like the upper surface, and sometimes there is a very different shade in the colour which tinges the leaf. Some leaves are almost transparent like glass, and others altogether impervious to the rays of light; though covered with a membrane which conceals the plexus, beautifully displayed when the cuticle is removed, there is one exception at least, already mentioned in the windowed or wire-gauze leaf of Madagascar, hydrogeton fenestralis. The figure is copied from a skeleton leaf of the Alexandrian laurel, ruscus racemosus, which

exhibits the fibrous structure of that leaf. The leaves of the *phormium tenax,* or New Zealand flax, are extremely beautiful, and now promise to be an object of commercial enterprize. Hitherto this plant has been only known as a rare inmate of the greenhouse, but there is sufficient evidence that it will brave our winters; and if we mistake not, one has already flowered, *sub die,* near Birmingham: it has succeeded remarkably well out of doors with me, and already braved six winters, on the coast of Scotland, without the slightest injury. My plants are as far superior to the sickly inmates of the greenhouse, as can well be imagined. Last November, I measured one of the external leaves and found it to be upwards of *six feet long* by *three inches and a half* at its greatest breadth. It has with me been entirely exposed to the influence of the sea breeze, and the soil is sandy. I lately obtained a pacquet of the seed of the phormium tenax, sent to this country from New Zealand; it is light, jet black, glossy, and of a flat texture, like that of the parsnip. I am informed that the plant is cultivated in a heavy clayey soil; should the seed not make its appearance in due time, a fire of brushwood is kindled on the spot by the natives, and, under such circumstances, the seed seldom fails to make its appearance soon after, no doubt arising from the alkaline matter, or the iodine of the ashes.

According to Rutherford, the phromium tenax, after being cut down in New Zealand, is carried home in a green state, it is then scraped with a large mussel-shell; and the pith being removed, it is split open with the nails of the thumbs, which the natives leave long for this express purpose. They use combs also for a similar operation. The fibres being then bleached in the sun, become as white as snow. The figure will give a tolerably accurate idea of the appearance of this stately plant when in flower. Mr. George Bennet says it is called *Koradi* by the natives. It is indigenous to the soil, and regarded as sacred. Though it grows in moist marshy soil, Mr. Bennet has seen it on the declivities of hills. Its leaves are ensiform, and its foliage he states to be from five to seven feet in height, so it should seem that the leaves of my plants, in the climate of Scotland, vie with those of its indigenous clime. The pedunculus, or flower stalk, rises above the foliage from four to five feet, and bears a profusion of flowers of a reddish yellow colour, succeeded by triangular seed vessels: the leaves grow erect.



The flax is obtained from the leaves, where the fibres are longitudinal, covered with the epidermis: there appears to be several varieties, or different qualities of flax. Fishing lines, mats, and wearing apparel are made of this flax. Hitherto it has only been employed in England for cordage. By the natives, the flax is called *Muka.* Females are employed in the process of preparing it, which is first soaked and then beaten. Mr. Bennet thus describes the process. "The leaves when full grown are cut down, the best are selected, and a lateral incision made with a shell on each side of the leaf, nearly to cut through the epidermis, the shell is then with a gentle pressure drawn from one of the incisions rapidly down the leaf, and is afterwards repeated on the other side: by this means the whole of the epidermis is removed, and the internal epidermis, which is thin, usually remains: the internal epidermis agglutinates the fibres; if not removed at first, is subsequently separated with difficulty, and if it remains, deteriorates the flax." This descriptive detail is interesting in reference to a plant that seems to promise considerable interest from its economical importance.

Hitherto our attention has been confined to the consideration of the decorations of terrestrial foliage, but if we regard the leaves of aquatic plants we shall find as much to admire; some singularities in aquatic plants will be hereafter mentioned; but it would be difficult to find a more beautiful subject of contemplation than the surface of the waters, mantled with the beautiful floating fronds of water lilies, with their snowy chalice nestling here and there among them: not to speak of the cyamus nelumbo, or sacred lotus, and all its beautiful congeners, such as the *speciosum,* and others. There is a singular and interesting fact connected with aquatic vegetation, which must not be overlooked ; some aquatic plants rise above the surface of the water to evolve their flowers, and perfect their seeds ; for instance, the ranunculus aquatilis, or water crowfoot ; a very common plant, and abundant in pools and ditches : this plant has *two* classes of leaves, those that are under water are divided into conferva-like leaves, but those which rise above the surface, have considerable discs. It is therefore truly an *amphibious* plant, and finds an analogy in the *siren lacertina,* supplied with two classes of pneumatic apparatus : the branchiæ, or gills, for breathing in water, and lungs for breathing in the atmosphere : we merely state this by way of illustration, as in many aspects the analogy would entirely fail. Floating leaves afford shelter for aquatic animals ; and fish thrive better where there is a healthy aquatic vegetation. These floating discs, too, afford a buoyant raft, for some kinds of birds in search of aquatic insects. See plate II. fig. 15. Labillardiere states his having seen the Chinese jacana, one of the genus *parra,* walking with graceful agility and lightness, from leaf to leaf of the cyamus nelumbo : its toes and nails, which are of an immense length, seem to qualify it for this purpose : their extreme length reminds us of the snow shoes worn by the Laplanders.

The callitriche aquatica, or water star-grass, the stellaria aquatica of Ray, and known also by the name of water chick-weed, is sometimes so thickly matted together, and so dense as to bear a person walking on it. A natural paper was discovered already formed at Cortona, from aquatic vegetation. I found a curious production of this kind, now in my cabinet; it is a natural paper, which I picked up, and the produce of a dense and compact disc, composed of *conferva fracta* with a sprinkling of the *lemna,* about the thickness of thin brown paper, of a light colour, and is indeed a paper which bears the ink very well. My specimen is about 18 inches square, and was evidently formed of a matted tissue of the crow-silk left on evaporation of the water; no doubt the natural paper of Cortona, is owing to the same cause.

Islands, which are truly emerald isles, are formed by masses of vegetation detached by the eddies and currents, or the swell of rivers; these floating islands, which are interwoven with drift wood, according to Humboldt are dangerous to navigation; they are covered with aquatic plants, and resemble a meadow floating on the abyss of the ocean.

Leaves when expanded become a most essential part of the vegetable structure, and bear a remarkable analogy to the lungs or gills of animals; it is here that the sap is perfected, and undergoes a series of electro-chemical changes, under the influences of the sunbeam: from the leaves, the sap previously conveyed to them by the conducting vessels of the wood, descends by the returning vessels of the inner bark, which are found in juxta position with the wood. Cesalpinus considered leaves in the character of a covering for the plant, or its mantle of protection from the extremes of heat and cold; and doubtless, the chilling influence of radiation, and the direct action of the sunbeam, will be modified and blunted by them; hence it was observed that when plants were despoiled of their leaves by the ravages of the caterpillar, the fruit either did not ripen, or if it became mature, it lost all its excellence. The leaves of plants subserve however a higher purpose, than this supposition amounts to; they absorb and respire gases; absorb and exhale aqueous vapour, and there can be no doubt that they also include secreting organs of a description peculiar to themselves. It is certain that leaves and their adjuncts contain medicinal and other principles of a very powerful character; the foxglove and the senna might be referred tō, and in some cases perhaps peculiar secretions, are confined to the leaves. The laurel leaf is eminently dangerous for the hydrocyanic acid it elaborates, but we have been told of an individual who was constantly wont to chuckle up the berries with impunity; and Gipsies bake these berries in pasty, and use them as food. Indeed, from attention and long consideration of the subject, and drawing our inferences from established facts, we have concluded that each part of the plant has its peculiar organs, which secrete principles independent of the rest,—the root, bark, leaf and flower: hence the poisonous secretion of the root of jatropa mauihot, the aromatic bark of cinnamon, the rubefacient principle of the leaf of carthusa matthiola,* and the aroma of the rose, which yields the far famed attar of roses. A willow was deprived entirely of its leaves, and it soon issued a new succession; these were also removed, and the plant died. The mulberry may be denuded again and again of its leaves, to supply the silk-worm, and as it seems the almost exclusive food of that interesting insect, so singularly useful in its produce, as the nopal is of the cochineal insect, the plant seems eminently calculated to sustain the repeated spoliation and denudation—exceptions from the general rule are provided, where exceptions are essential and necessary. We shall, in another place, be more specific on the respiratory functions of the leaf, and confine our present remarks to the transpiration of leaves and their exudations; the leaf is amply supplied with orifices, which are of various sizes and forms: in the myrtle these are extremely minute; and in the oleandar comparatively large. In many leaves, no orifices can be discerned on the upper surface, as in the hydrangea quercifolia, the daphne mezereon, and others; but some are plentifully supplied on both surfaces, as the rumex acestosa and iris germanica. The theophrastus contains 172,032 orifices on each square inch of the under surface, but none on the upper surface; the hydrangea quercifolia, in like manner, contains 160,000 orifices in the same space of the lower disc. Its transpiratory functions are very active, and if the plant be not constantly and abundantly supplied with water, the leaves wither and are dried up. When plates of glass, or better, metallic surfaces, as those of silver or copper, are applied to the upper surface of the leaf, they will condense no moisture, but it is otherwise when they are applied to the under surfaces of leaves; when the under surfaces of leaves are varnished, so as to obstruct their functions, those leaves fade. In succulent plants, such as cactuses, and stapelias, the root is only a subordinate source of support, and their entire surface is the chief medium of supply. The cuticular orifices seem chiefly designed as exhalent mouths, and absorbent surfaces seem to be void of them, so that absorption appears to depend on functions unconnected with visible orifices; succulent plants absorb freely, but exhale sparingly, and varnished surfaces seem expressly designed to prevent evaporation, or rather transpiration: floating leaves, on aquatic plants, are unsupplied on their under disc with cuticular orifices, while their superior surface is amply supplied with them. The stems of the water crowfoot have their two sets of leaves differently supplied in these respects. The exhalation of the leaves of aquatic plants seems extremely copious: that very common aquatic plant, the pond-weed, potamogeton, withers quickly when removed into the air; and in the leaves of the water lily, and its kindred tribes which float on the surface, while the lower disc is in contact with the water, the upper disc is constantly maintained dry; and even water rolls off these leaves like globules of mercury from glass;—the mosses are remarkable for their absorption of moisture, and subserve a most important purpose in creation, they condense the dews; their beautiful foliage being a powerful radiator of caloric; and if judiciously managed, might be economically applied to maintain a perennial spring. The moss, by long continued drought, seems to suffer; it contracts, and apparently withers; but when dews fall, it unfolds its green drapery, and is as refreshing to the eye as before; so that the effect of long continued dry weather seems to be transient and temporary; even when moss has been cast aside for years, if immersed in water, it grows green again.

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* If a leaf of this plant be applied to the cheek, it leaves a blush, which remains permanent for a fortnight—a natural rouge.

Bonnet placed a series of leaves from various plants on the surface of water, some with the lower discs in contact, and others reversed; of fourteen leaves, from so many herbaceous plants, six lived nearly as long with one surface in contact with water as the other; among these were the common arum, and sunflower; six others, the plantain, cockscomb, &c. lived longest with the superior disc in contact: the nettle lived only three weeks with its under surface on the water, but survived nearly two months in the contrary position; the amaranthus did not live a week when the under surface of the leaf reposed on the water, but when the upper surface of the leaf floated in contact with water it lived three months. The stalks of some plants immersed in water, succeeded better in preserving them alive, than their leaves; in other cases, the reverse: the plantain and white mullein survived longer when their several stems were immersed, than when the under surface of the leaf was incumbent on the water, but by no means so long as when applied to the upper discs of these leaves. The aspen, and lilac leaves, seemed to imbibe water indifferently by either surface: the leaves of the mulberry, morus alba, exhibited the most striking difference in the surfaces of its leaves; when the *upper* surface was, contrary to herbaceous plants, in contact, the leaf perished in five days, while the leaves that floated with the under surface resting on the water, lived nearly six months. The vine and some others decayed, almost as soon when supplied by the upper surface of their leaves, as when left without water altogether. Rose leaves, among others, absorbed sufficient, by those that were in contact, to maintain in undecayed vigour, the foliage of the branch of which they formed a part.

The transudation of the leaves of several plants is sufficiently remarkable. In calm hot weather, groves of the willow, or the poplar, will distil from their leaves a limpid water, which falls down like a gentle shower of rain. This exudation is saccharine in the orange and others of the genus citrus; it is glutinous in the lime tree, and resinous in the cistus creticus; an inflammable vapour rises from the fraxinella, dictamnus albus; and manna is the produce of the leaves of the ornus rotundifolia or manna ash, and some other trees, from the leaves of which it is collected.

The remarkable attachment of leaves to light has long been observed. "I have taken," says Sharrock, "young seedlings in a pot, and put them in a window where there was a square out, the seedling would immediately lose its upright growth, and direct its body straight to the hole, and so become almost flat and level with the earth in the pot; then turning it, the figure would make a horn or C, and then the letter S." The upper surface of leaves is generally varnished, pervious to light, but impervious in such cases to moisture; the under surface is unvarnished, and light seems to act hurtfully on it, as appears evident from plants always turning the upper or glossy surface of their leaves in the direction of the light; the branches of plants acquire by this means in a window, without vertical light, an unnatural appearance, being bent toward the window; and when the plant is turned in the opposite direction, this inclination to the light is soon manifested by the plant bending the contrary way. Should there be the light of candles, or of the fire in a room where plants are reared, and sun light excluded, the inclination of the stems and leaves will be toward the artificial light: hence plants in the narrow deep clefts of rocks shoot up slender and delicate stems, from their profound abyss, 'to rise into day;' and in the impenetrable thickets of forests, some plants, thus struggling for existence, spring up from their dark recesses to the height of more than a hundred feet, and tower above the trees, that threatened to extinguish them. The straggling stem of a potatoe, in a dark and deep cellar, crept through the key hole; and in one case, I was informed, of a potatoe, the stem of which stretched itself from the subterranean cellar, clambered, between the lath and plaster, and the wall, and made its way through a small orifice in the wall on the second floor.

Some leaves, it has been observed, are of a fibrous consistency. The gorteria ringens is, when in flower, a very ornamental plant. The membrane, on the under side of the leaf, is susceptible of considerable tension, and when twisted forms a thread of considerable strength.

CHAPTER V.

The Blossom—Its Rainbow Array—The Phenomena of the Flower, and relations to Light.

THE flower or corolla is that painted physiognomy by which the plant is recognized; and referred in the Linnean arrangement to its individual station among the tribes of vegetation. The corolla contains the elements of its recognition as to class and order in this beautiful system, which will maintain its ground, when the authors who have assailed it, with all their flippant and arrogant pedantry, shall have been forgotten: it is not too much to say that what has been lauded as the NATURAL SYSTEM, is the most *unnatural* jumble of incongruities that ever were collocated together. That the simple and truly beautiful system of Linneus is faultless, or the unclouded symmetry of perfection, none pretend to assert; but that this gifted genius and master-mind was not preternaturally endowed with that peculiar prophetic vision which would have enhanced his mental achievements, with all the enchantments of future discoveries, cannot reasonably be imputed to him as a fault. What was NATURAL HISTORY before its NEWTON appeared? "rudis indigestaque moles," and to the question,

"——Quisquis fuit ille, qui secuit congeriem,
Sectamque redegit in membra?"

We boldly answer in the affirmative—LINNEUS ;—prototype of that interesting little plant, named in honor of the illustrious Swede, the LINNEA BOREALIS, thus affectingly described by Gronovius,—" a depressed abject northern plant, long overlooked; flowering at an early age." I know not that any acquisition has ever so much gratified me than to meet with this little gem among the mountains of the " great glen" of Scotland. It is the fashion of the day, however, in its innovations of natural history, to impugn the gift which this great man bequeathed to naturalists and natural history ; but when we look at those who launch these weapons, we may well be astonished. We keep within the fence of prudence, when we hazard the bold assertion, that if the greater part, if not all of the living naturalists of our times, were condensed into one, that living head has not done for natural history what Linneus singly accomplished. I profess freely and undisguisedly my fond attachment to the system propounded by Linneus, whom I would characterize as the decus humani generis :—

> " With all thy faults, I love thee still."

Pliny, with rare felicity, characterized the flower as the 'Joy of Plants,' *Flos gaudium arborum* ;—the rose, the amaryllis, and the tulip are splendid attestations to this poetic truth. The corolla is adorned with all the coloured imagery of the prism, sometimes singly, at other times mingling its chromatic rays together on one disc, as if the rainbow had impressed its beauteous seal on the fair canvass of the flower. At other times we find the flower of dazzling whiteness, unrivalled even by the snow. 'To paint the lily,' is proverbial for what cannot be improved; and who would dare to do it? Besides its showy ornaments, the fragrance of the flower, as in the rose, is not less delightful, though there be some that cannot so well compete for the distinction; but the incense of flowers is often wafted afar on the breeze, particularly remarkable in the spice islands, the approach to which is announced at an immense distance at sea.

These beautiful insignia of trees consist individually of a variety of parts, all contributing their share to the perfection of the whole: the bractæa, or floral leaves, sufficiently conspicuous and distinct in the artichoke, are sometimes present, and at other times absent; sometimes they are green, as in the case referred to, as well as hypoxis erecta; or they are coloured, as we find them to be in the examples already cited. In the bartzia coccinea, the bractæa are a bright scarlet; in the tilia europea, a pale yellow; and in the salvia hormium, a beautiful purple. The bractæas are more permanent, usually, than the calix: the calix or flower-cup is commonly the colour of the leaf, as in the pink and carnation; though it is also occasionally coloured, of which the fuschia coccinea or common fuschia, affords a beautiful example; the scarlet, or rather crimson envelope, being a true calix, while the rich purple fillet it encloses is the corolla.

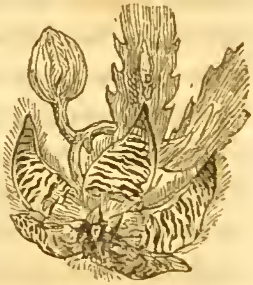
The corolla is usually distinguished from all other parts of the plant by its rich and brilliant drapery—it is frequently white, but usually painted with the most exquisite colours, and sets all art at defiance to imitate. One example of a green flower has been given, the flower of the daphne laureola is another of the same kind.

The variety in the forms of the corolla of plants is as countless as its hues: it is of one piece, as the bignonia or convolvolous, and of an elegant bell shape in the lily of the valley, convallaria majalis,—

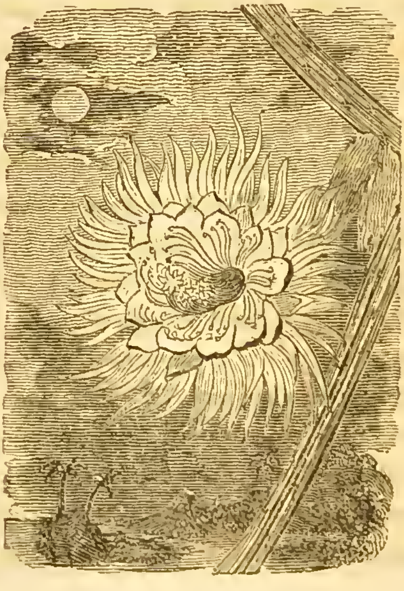
> 'The silver mistress of the vale;'

or, composed of numerous segments or pieces, as in the white and orange lilies. The palms exhibit that peculiar form of corolla called the spatha or sheathe, of which the beautiful white fillet of the cala ethiopica, forms an elegant type: the personate or masked, and the ringent corollas are singular and curious: the snapdragon and monkey flower will readily occur as examples. Among these are to be found the lobelia cardinalis and fulgens, as well as the salvia splendens; rich and dazzling in the attire of their corollas. But in point of singularity of structure, they are surpassed by several of the orchideœ; in the fly orchis, ophrys muscifera, the flower so much resembles a fly that it might be readily mistaken for one.

In the ophrys apifera, and aranifera, the flowers exactly resemble the bee and the spider: but the most curious of all is the green man orchis, aceras anthropophora, which exhibits the liliputian resemblance of a human figure: thus too the bird's nest orchis: the bee larkspur is equally remarkable; and that interesting flower, the cypripedium or ladies' slipper, displays a similar singular form in the corolla. There is a British species in the north of England, but it is rare, and may justly be termed the queen of the European orchideœ. The cypripedium insigne from the mountains of Sylhet, is equally elegant and beautiful. One of the air plants, an epidendrum, exhibits a flower in the form of a spider; and another one, a dendrobium, figured in the 'Plantæ Asiaticæ Rariores,' is very peculiar in the conformation of its corolla. That singular plant, called, from its power of resisting long continued drought, the 'vegetable camel,' or stapelia, which blooms in the desert, often 'to blush unseen,' displays a most extraordinary flower, somewhat resembling in its contour the 'starfish.' The stapelia stellaris is the scarce species of a genus numerous in the deserts between the mountainous ridges above the Cape of Good Hope. Their fleshy and succulent structures are well adapted to enable them to sustain the parched clime of these arid regions. The figure represents one of these singular flowers, which corresponds in size to that of the plant, rarely seen above ten or twelve inches high. The flower blends great richness of colour with a succulent fleshy texture, smells somewhat like carrion, and probably becomes, in consequence, a source of attraction to the insect tribes, doubtless intimately connected with the curious economy of the plant.



As to the size of the flower, it varies from a scarcely visible point to a *circumference of nine feet.* The largest flowers hitherto discovered are the raflesia arnoldii and the raflesia patma, the former of which is nine feet, and the latter six feet in circumference; but the most curious part of their extraordinary history is, that they are *mere flowers,* without root, stem, or leaf; so diversified is that proteus thing called a PLANT. We naturally assume that to constitute a plant, it must be possessed of specific parts: root, stem, leaf and flower, are features which, in the mind's eye, are essential to the constitution of a proper and perfect plant; but in the tuber cibarium, we perceive a root, and nothing more, yet it is a plant. In the raflesia and brugmansia, it is a flower, and only a flower, though doubtless these too are plants; and in some of the algæ and lichens a leaf, and a leaf alone, still these are plants. Generally these, though thus detached and separated, are all united into one. In the previous cases they figure in parts, and all are perfect of their respective kinds. The definitions of our prescription are frequently outwitted at every point. General rules may doubtless be legitimately imposed to aid our progress, but let us not, Procustes like, endeavour to subdue creation by artificial lines of demarcation, and call peculiar phenomena anomalies; because they may not be found to square with preconceived notions: the genuine philosopher is often puzzled and at his 'wit's end,' and none will be more ready than he to acknowledge his perplexities, or sooner assent to the necessity of Lord Bacon's maxim,—that, 'if we would gain knowledge, the mind must needs be subdued.' Frequently, however, this sage lesson, which lies at the very root of the principia of inductive science, is forgotten, and the result of its abandonment, may be easily foreseen. The maxim of Seneca was equally apposite and just: " Many might attain wisdom, if they did not suppose they had already reached it." Among titan flowers may be named that of the cactus grandiflorus, indigenous to Jamaica and Vera Crux. It is nearly twelve inches diameter, or about three feet in circumference; the numerous petals are a pure white, and the inside of the calix a splendid orange; it opens for a few hours in the evening, and after shedding its fragrance around, shuts to open no more; it begins to unfold about seven or eight o'clock in the evening, and has finally closed its



magnificent inflorescence before sunrise. Some beautiful specimens of these plants are seen occasionally in the conservatory of this country. Our figure exhibits one of these nocturnal beauties. We are informed that in the present month (June) a fine specimen of the cactus grandiflorus has flowered with unusual splendour in Mr. Maule's hot-house, near Bath, having no less than nineteen blossoms, which began to open between the hours of seven and ten o'clock P. M. The cactus speciosissimus is a brilliant species, and its beautiful corolla in some cases we have seen nearly ten inches in circumference. The Indian children, on the river Magdalena, wear the blossoms of the aristolochia for caps. In the magnolia grandiflora, the corolla, which is composed of snow white thick petals, to the number of from fifteen to twenty-five, resembling shell work, is more than two feet six inches in circumference. Among the lakes of the Arkansas, in America, is found a magnificent species of nelumbo, perhaps the speciosum. The leaves are described as being the size of an ordinary parasol, and the diameter of its imposing corolla about ten inches, formed of white petals. The sandpiper, and other birds, trip along these leaves; and sometimes moccasin snakes bask on their surface. Indeed aquatic birds not unfrequently build their nests and rear their young in the cavities of the floating leaves of the lotus. The flowers of the adansonia digitata, boabab, or monkey bread, are white, and exceedingly striking, they are eighteen inches in circumference.

The splendid and magnificient tufts and canopies of flowers, in tropical countries, are truly imposing, and sometimes impart even a new character to the scenery of a country. Immediately after the periodical rains, the beautiful white blossoms of the cordia abyssinica suddenly expand, as by magic. It is planted in every town, and according to Mr. Bruce, invariably blossoms on the first of September. Such was the profusion of flowers on one occasion, mentioned by this celebrated traveller, that Gondar, and the other towns, appeared on the following day as if they had been visited with a fall of snow. The magnolia insignis, found by Dr. Wallich in the great valley of Nepal, is described as truly magnificent: it is a tree of great magnitude, the trunk being four or five feet in diameter: the large, fragrant, and beautiful yellowish-white flowers are produced in myriads, among dark green leaves, and these are succeeded by oblong cones of purple capsules, from which its scarlet seeds are suspended by delicate white filaments. The foliage of the nauclea orientalis is decorated with thousands of little golden globes of flowers. The bombax insigne is also a splendid plant, adorned with bright scarlet flowers; but the AMHERTIA NOBILIS, 40 feet high, with its delicately beautiful pinnated leaves, and magnificent canopy of pendant vermilion flowers, so exquisitely represented in Dr. Wallich's imperial work, must hold a chief place even among the flora of India: the Burmese decorate their temples with these floral forest ornaments. The baringtonia is a beautiful tree, and remarkable for its abundance of flowers, larger than lilies, of a pure white, relieved by the anthers within, which are of a rich crimson colour. On one raceme of a seje-palm, Humboldt estimated the number of flowers at 44,000. The scarlet flowers of the chandelier shed their brilliant lustre over the wastes of Africa; while the light and elegant form of the mimosa, introduces the traveller to its sterile deserts; one of these is thus described by Mr. Campbell on the road to Beaufort: "It attracted my attention," says he, "by the greenness of its foliage, and the number of the flowers with which it was studded; these glittered in the sun, like so many new coined guineas. It consisted of 17 long shoots proceeding from one ancient stump. The circumference of the ground which it shaded measured sixty-six steps: our cattle were feeding around; coveys of pheasants were flying over it; butterflies, of great beauty, were extracting their food from its honied treasures; and lizards, of various hues, were enjoying its shade." A beautiful mimosa is also figured in the 'Plantæ. Asiat. Rar.' In New Zealand, according to Mr. Bennett, the knightea excelsa towers high above its fellows; glowing in tufts of crimson blossoms, and here and there the edwardsia macrophylla mingles its pendant carinated blossoms, of a golden hue, in the scene of vegetable grandeur. Even some lowly plants are decorated with countless myriads of these 'gaudia arborum.' Sir A. De Capel Brooke mentions a beautiful miniature rhododendron, which he found in Lapland. The whole plant might be covered with the hand; yet the number of flowers exceeded a thousand. Plants that can scarcely be called *trees;* and others that seem, in some of their species, to connect the herbaceous with the arboreous form, unfold flowers of immense size; and remarkable for their multitude. In the year 1818, on the Isola Madre, in the Lago Maggiore, I saw a fine agave americana in bloom: the plant, which had maintained possession of a cleft in the rock, on the verge of the water, carried a flower stalk twenty-seven feet high, and measured twenty-two inches in circumference at the base; its flowery canopy was one of the most imposing spectacles I ever beheld. In 1825, I was equally fortunate to witness, in the Isola Bella, the flower of the agave filamentosa, thirty feet in height; it had then been in bloom twenty-six days, and was computed to be about fifty-six years old. An agave americana flowered, sometime ago, at the seat of the Marquis of Westminster, which had a flower stem twenty-five feet high; there were 3000 flowers sustained on thirty-two flower stalks, branching from the main pedunculus, or flower stem, like a magnificent chandelier. In the tropics, the humming bird is seen fluttering in vast numbers about the flowers of the great American aloe. The floral splendour of groups of these magnificent flowers would be sufficient to arrest the astonished spectator, but with such an adjunct as this, a stoic might be roused from his apathy. Sometimes, according to Mr. Waterton, the salvia splendens is the point of attraction for these feathered gems of creation: "Now," observes our author, "it flutters from flower to flower, to sip the silver dew: it is now a ruby, now a topaz, now an emerald, now all burnished gold!" The humming bird seems to have no indifferent choice in the flowers it selects, the fuschia coccinea being one of the number. The golden wren, in this country, may be sometimes seen fluttering within the blossom of the crown imperial. Even the hydrangea hortensis often exhibits immense luxuriance, both in foliage and flower. In the Isola Bella I have seen a plant ten feet high, and fifty feet in circumference, which had carried 616 bunches of flowers, each larger than the human head, and maintained its imposing inflorescence for a period of five months. The tree peony, or peonia moutan, from China, is now a general ornament, and appears hardy: it requires no protection with me. Two very fine plants, nearly five feet high, and of considerable circumference, I observed sometime ago at Lord Clive's. At Henley-on-Thames is a peonia moutan five feet and a half high, and twenty-seven feet circumference: last year it carried 230 bunches of flowers, each six inches diameter. The yucca gloriosa has occasionally exhibited, even in this country, flower stems, so studded with blossom, as to be only rivalled by the great American aloe.

Generally the flower or blossom is displayed at the top of the plant, or termination of the branches; but is not unfrequently unfolded on other parts of the plant, as the axillæ. The xylophylla bears flowers in the serratures of its leaves; and the ruscus on their superior disc,—while the ferns wear their flowers on the lower surface of their leaves. In the primrose and cowslip the flower emerges from the root. Among those plants which bear flowers on their stems, such as the great mullein; the cercis siliquastrum deserves specific notice. This tree is found on the sides of Mount Lebanon: the flower unfolds before the leaf, and springs from the branches in every part; the bright pale red flowers pierce the thick strong bark of the trunk even to the root, in a very remarkable manner; and in spring gives a ruddy hue to the shores of the Bosphorus.

Some flowers are remarkably permanent, and may be preserved unfading for many years after they are removed from the plant; to this class belong those flowers which are commonly called 'everlastings,' of which the xeranthemum lucidum is a fine example; garlands of these are sometimes employed to crown the busts and monuments of the 'illustrious dead,' in the cemetry of Pere la Chaise; nor could I resist the sympathetic impulse of adding yet another coronal of 'everlastings' to the tomb of one whose memory I venerate: I mean the Abbé Sicard, whose benevolence to an unfortunate part of our species, the *sourds-muets,* or deaf and dumb, was so remarkable a trait in his character. It may be mentioned in this place as singular, that these flowers when put into water merely by their stems, contrary to what takes place in reference to the rose of Jericho,* completely close; and I found this to be the case with 'everlastings,' that had been put aside for many years: when the moisture exhales, on the removal of these flowers from water, they soon expand again.

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* This curious plant being found on the plains of Jericho, skirted by the Jordan, may perhaps have suggested its trivial name.

But while there are some flowers characterized by permanence, both in duration while they remain attached to the tree, and after they are separated from it, there are others truly ephemeral and evanescent; the short lived flower of the cactus grandiflorus has already been mentioned. The hæmerocalis, or day lily, is descriptive of its brief career: the gum cistus, though an ample succession of inflorescence is maintained, is extremely fugitive;—that delicate and beautiful rose, the 'celestial,' appears to me the most fleeting of that lovely family of flowers. The tiger flower, tigridia pavonia, seldom survives a period of four hours; and the moræa tristis, even with the choicest care, perishes in less than three hours. It is in the contemplation of these ephemeral beauties that we are chiefly impressed with the representation of our own duration, as sketched by the emphatic pencil of Truth:

> 'The goodliness of man is as the flower of the field.'

The flowers of many plants possess medicinal virtues, and not a few are endowed with the most delightful fragrance. The jesmine and the rose are examples: immense are the quantities of the Damascus rose, cultivated in the east for its delicious perfume. In the 'sketches of Persia,' there is the description of a breakfast given near the Hâzar Bâgh, or 'thousand gardens,' near Shiraz; and celebrated on a stack of roses. "The stack, which was as large as a common one of hay in England, had been formed without much trouble from the heaps or cocks of rose-leaves, collected before they were sent into the city to be distilled." We once heard a courier, who brought despatches overland from Constantinople to the British Government, mention that he was attacked on his journey by a band of robbers, and plundered of every thing, including his despatches: several bottles of attar of roses were among the spoils: by the accidental fracture of one of these bottles, the den of retreat of the banditti was providentially discovered, and the property finally recovered. The rose has been a favorite flower in every age and in all countries. It held a high place in the esteem of both the Greek and Latin Poets: Anacreon calls it the "Ornament of the Graces;" and the twice blooming rose of Pestum,

"Biferique rosaria Pesti,"*

we have incidentally before alluded to. The flowers of the bassia butyracea are collected and dried in the sun, and form a preserve, which has been compared to Malaga raisins. That the painted corolla of the flower is importantly concerned in preserving the temperature necessary for sustaining the functions of the plant in the organs of fructification, there can be no proper question. There is in a garden at Burlington, a petalless apple tree, which bears fruit very well; and some of which I believe I have at this moment in my possession; but these apples are without seeds. I have not had an opportunity of examining the inflorescence, but am assured that the other parts of the flower are perfect.

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* Dr. Schouw told me he had searched in vain for this celebrated flower in the country around Pestum.

Mr. Hunter ascertained, by direct experiment, that vegetables possess a specific temperature, which proves a defence against the destructive inclemency of a low medium; but the most remarkable increment recorded, is that of the arum maculatum, which Lamarck states to be 'so hot' for some time, 'as to seem burning.' M. Sennebier ascertained this period of incalescence to be that when the sheathe is about to unfold. When the ambient air was 13· Reaumur, equivalent to 66· F. the flower was 7· R. higher or 81.5 F. On the 31st May 1824, I found when the ambient air was 77· F. that the temperature of the purple garden iris, in the shade, and before expansion, was 81· F.* These facts prove a series of chemical changes, connected with the physiology of the coloured corolla of the flower.

The following experiments made on the temperature of a variety of Roses, at different periods of the unfolding of the flower bud, seem to prove in like manner, that an increment of temperature accompanies the evolution of the corolla of that flower, and a curious fact has been communicated to me, which may be cited in connection with this question, while it seems corroborative: namely, that a *hot* iron brought near to the flower bud of the cactus grandiflorus, or night flowering cereus, will occasion its *immediate* evolution. The air was 50·5; the bud of the *moss rose* indicated 53·5, more advanced 54·, expanding 54·5. *Rose unique* (white) unfolding, 55·, air being 54· ; *cabbage rose,* unfolding 56·, more advanced 57·; *Tuscany rose* unfolded 55·5. In the following the temperature of the air was uniform at 52· ; a red rose bud unfolding 56· ; another unfolding 56·5 more advanced 58· ; a third unfolding 56· ; *celestial,* 55· ; *mourning rose,* 53· ; *favorite purple,* expanding 55· ; fully expanded, 53. It will be seen from the experiments hereafter detailed, that in the sunbeam each individual colour of the chromatic series, as arrayed on the painted disc of the flower, denotes the evolution of a peculiar grade of temperature, in exact unison with that evolved in the same tint of the prism ; and it appears to me, that this grade, determined by thermometric measure, is a faithful index and record of the amount of chemical agency and corresponding change. The late Sir Wm. Herschell found, that a delicate thermometer, placed in the *violet* ray of the solar spectrum, indicated an acquired temperature of 2· above the ambient atmosphere. The *green* exhibited an increase of 2.25·, and the maximum of temperature in the *red* ray amounted to 4·5833 F.+ We find these interesting results confirmed by the late Dr. Wollaston, whose name mingles with the most interesting revelations of modern science. Others have afforded their countenance to the same conclusion. It would be out of place here to introduce the detail of these experiments ; I may, however, be permitted to advert to a few phenomena, which at once verify and extend these facts. I have discovered, that each colour of the prismatic series, displays at the instant of its evolution, or production, a corresponding and peculiar temperature.—I shall cite examples. Distilled water, with a few drops of tincture of iodine, gave a temperature of 46°; and a small portion of boiled solution of fecula added, produced a beautiful *violet* tint, while the thermometer rose to 47° F. being an excess of 1° Equal volumes of solution of nitrate of iron, *a* 50° and of hydrocyanate of ammonia, *a* 47° exhibited a temperature amounting to 50° F. being an incrcment above the average, of 1.5°, with the evolution of a *prussian blue* colour. Acetate of lead *a* 47° and chromate of potassa *a* 48°, in solution, and in equal quantities, yielded a temperature of 50° F. being 2.5 superior to the mean, and afforded a *bright yellow* colour. Solutions of the muriate of mercury *a* 50° and of hydriodate of potassa *a* 50°, in equal volumes, evolved a temperature of 57.5 F. being 7.5°, above the mean thermometric values, when a *brilliant red* was produced. The caloric resulting from *chemical* action soon subsided; and it was proved that *density* had no share in the superinduced caloric, for it remained *permanent.* The preceding experimental results, yielded, for violet 1°, blue 1.5, yellow 2.5 and red 7.5, above the *mean* temperature, being a regular ascending series of progression, and in approximate accord with the chromatic scale.

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* In another experiment, when the air was 63·5, the semi-evolved flower was 68· F.

The experiments of Theodore de Saussure on the oxygene consumed, and carbonic acid developed by the flower, harmonize with the conclusions I have formed; and verify my inferences, as grounded on the evolution of temperature in sunshine and in shade. The *colour* of the flower seems, however, to have been entirely overlooked in the estimate of M. de Saussure. The duration of these experiments seems to have been twenty-four hours, which consequently includes the *nocturnal* period. The thermometer ranged between 18· and 25· centigrade.* The healthful condition of the flower was determined by that of the parts of fructification. The measure of oxygene absorbed is relatively to 200 parts of atmospheric air, in which the flower was confined with the stem placed in water. The quantity of oxygene was supplanted by an equal volume of carbonic acid gas; under these circumstances,

The single tuberose, 9 o'clock a.m. had consumed 9 parts of oxygene, whilst the *leaves* had only absorbed three parts.
The white lily, 11 a. m. 5.—Leaves, 2-5 oxygene.
The passiflora serratifolia, 8 a. m.—Flower, 8·7. Leaves, 8·5.
The hibiscus speciosus, 7 a. m.—Flower, 8.7.—Leaves, 5·1.
Chieranthus incanus, 6 p. m.—Flower, 11.—Leaves, 4.
Hypericum calycinum, 8 a. m.—Flower, 7·5.—Leaves, 7·5.

The leaves, therefore, are, with the exception of the last, (where the proportion of consumed oxygene seems to have been the same in both cases,) less destructive of oxygene, than the inflorescence. M. de Saussure has proved, that, an oxygenated medium is that exclusively adapted to the healthful flower, and though the rose might appear to preserve an unfading dye, longer in azote and in vacuo, than in atmospheric air, yet, this fair exterior, only concealed an extended decay. M. de S. concludes, that the flower consumes more oxygene in *sunshine* than in shade, and that an elevation of temperature augments the destruction in question.

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* 61.4 and 77· Fahr.

I shall now give the temperature of various flowers, ascertained by a very delicate and sensible thermometer, being the results of experiments made by me during the years 1822 and 1823. On a stage in the shade, the cala ethiopica was 55· F.—The rosa odora, pale blush 56·, and Amaryllis Johnsoniana 57·. When the air was 54·5 F. the corchorus japonica indicated 56·. and the double red anemone 57.5. Again, when the temperature of the ambient air was 63·,—that of the blue bell was 64·; and of the thistle 64·5,—and the air being 58·,—the centurea montana was 59·.—and of the leontodon taraxacum or dandelion, 60.5. These exhibitions proved a temperature peculiar to each individual colour, and induced me to enter on a more extended range of investigation. From a numerous list of experiments, I shall select a part, the entire number being too diffuse for detail. I cite the examples in the order of the prismatic series.

White Flowers.

9 Sept. 1822, at 6 30 p. m.
Air 53.5.—Daisy, 52.5.
— 60.—Bramble, 59.5.
21 May, 1823,
Air 58.5.—Pond Weed, 57.5.
31 May, noon,
Air 81.—Narcissus, 80.5, (sunshine.)
— 74.5.—Ditto, 75.
24 July, 5 p. m.
Air 66·.—Semidouble Campanula, 67.5.

White coloured flowers do not differ materially in the heat evolved, from the ambient air, either in sunshine or shade; and therefore, it is probable, decompose *less* atmospheric air.

Blue Flowers.

21 May, 1823.
Air, 54.—Blue Bell, 55·.
30 May, — 70·5.—Blue Iris, 71.5.
31 .. 1 p. m. Air, 70 Ditto, 72.5, (sunshine.)
„ .. Air, 75.—Gentianella, 77·.
24 July, Air, 63.5.—Bee Larkspur, 67· (sunshine.)

The temperature is always superior, in sunshine, in all cases, *white* perhaps excepted; and all circumstances being the same, the evolved temperature will be in relative correspondence with the photometric power.

Yellow Flowers.

Air, 60·.—Leontodon taraxacum, 64·, (sunshine)
26 May, 1823.
Air, 63·. ditto 68., (sunshine)
30 12 o'clock, noon, Air, 70.5.—Ditto, 73·.
— 70.5.—Golden ball, 73.
31 May 12 30' p. m. Air, 83· Leont. tarax. 87· (sunshine)
Air, 82· Yellow horned poppy, 85· (sunshine)
— 80· Golden ball 84.5 (do.)
— 76· ditto 81· (do.)
24 July, 5 p. m. Air, 57.5 Single yellow rose, 61· (do.)

The uniformity of temperature in different flowers of the *same* colorific tint, is very remarkable. There will be always a constant relation to the ambient medium.

Red Flowers.

31 May, 1823, 12 30' noon, Air, 81 double red peony, 89· (sunshine)
1 & 30' p. m. Air, 75· ditto 82· (sunshine)
Air, 71· Flos Adonis, 72· (sun clouded
— 73 ditto 77. (sunshine brighter
24 July, 15 p. m. Air, 54· Rose, 58.5 } transient gleams.
Air, 59· scarlet lychnis, 61·

Proper allowance must of necessity be made for the ever varying changes of the illuminated medium, currents of air, and altered condition in the relative maturity of the flower; also the extreme difficulty, and delicacy of observation, and experiment; but with these stipulations in their favour, the experiments seem exceedingly expressive. It is quite remarkable to notice the effect of even a *passing cloud* over the solar disc.—In such circumstances, while the air was 71·, the flower of the adonis was only 72·; but on the returning gleam, the temperature rose 4· higher. The comparison between the air and flower was always made under similar circumstances:—if the temperature of the flower was taken in the shade, so was that of the air; if in the sunshine, then the ball of the thermometer in air was exposed to the sunbeam.

Many phenomena prove the devotion of the flower to light: plants in the window turn their leaves in that direction, even the daisy

> "That wee, modest, crimson-tipped flower,"

unlocks its bosom to the influence of the sun, as soon as that luminary emerges from the horizon. That it acts as a powerful stimulus is manifested by the consequences of privation. Plants accidentally introduced, and found growing in mines, instead of a healthful green livery, are pale and sickly. In the late arctic expedition, under Captain Parry, cress and mustard reared by the temperature of the stove, to the exclusion of solar light, seemed to possess their usual acrid and pungent qualities, but were completely etoilated. Of this circumstance horticulture has availed itself, and the process of blanching celery, cardoons and sea-kale, is merely hiding the stem from the light of day. The conclusions which naturally flow from the preceding observations and experiments are interesting. The increment of heat in sunshine, so constant in its ratio above the ambient air, and decrement and modification in shade, prove, that, by an increased chemical action in the former, and lessened chemical agency in the latter, an uniformity of temperature will be preserved in the plant; the excess of caloric being thus thrown off. The relative tints, too, have their corresponding ratios of temperature compensated for, because chemical changes supervene in accord with them;*—so that not only is the vertical solar ray of tropical climes, but the more oblique rays of elevated latitudes, equipoised in the case of vegetation; and, in like manner, wherever local diversity has its share in the beauteous and beneficent arrangement; that varied feature has not been overlooked. The analogy which obtains in the animal economy, must strike the attentive enquirer. Thus it is, that the temperature of the system in the animals of Nova Zembla, "Torneo's hoary cliff," or Melville Island, and those which range under the equator in Borneo, Madagascar, and Sumatra, is invariable and uniform. Here, the phenomenon is common to all, and the chord of health vibrates at 98° F. The remarkable capabilities of the animal economy to maintain this singular uniformity, are forcibly expressed in the experiments of Banks, Blagdon, and others. Thus flowers indigenous to an *ultima Thule,* will preserve an uniform temperature, in an atmosphere with "ice still lingering in its veins," while the plant that bears the same prismatic tint, and glows in more brilliant and richer dyes under a vertical sun, will sustain the same relationship, let the ambient medium be what it may, or the photometric powers ever so exalted; and enjoy, like the fabled salamander, a cool siesta amid a burning pile. Such are the phenomena connected with the exquisite machinery of the corolla of the flower.

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* That chemical changes may be announced by colour, appears to me, proved in the successional tints of autumn, and the phenomena of many changeable flowers.

As the corolla opens influenced by light, so it shuts when clouds interpose, or the sun sinks in the western horizon. In an eclipse of the sun, the pinnate leaves of the mimosa fold up, and on its transit from obscuration, they re-open. In gloomy weather, when saddened by rains, the crowfoot and others shut their flowers; the valisneria spiralis withdraws its blossom; the pondweed reclines on the surface of the water, while the daisy, during night, will be found recumbent on the earth. The 'sleep of plants' is of this description: when solar light disappears, or is attenuated, as in twilight, the flower shuts, and the pedunculus, which supports it, bends towards the earth. The reason is obvious; the absorption of oxygene, and evolution of carbonic acid gas, no longer continuing to minister that temperature by which the fibre elongates and the flower unfolds, the vessels contract, and the plant falls into a state of comparative asphyxia. It is impossible to conceive of a superior defence against the effects of radiation to a nocturnal sky. The cells containing the pollen have already burst in the sunbeam, and the effect of so vast a cooling power would prove fatal to the entire apparatus destined to secure the perpetuity of the vegetable tribes. I found in the twilight of the evening of the 21st May, 1824, that the air being 55· F· the thermometer introduced into the shut corolla of the meadow crowfoot, indicated 53· F. The following additional experiments corroborate the fact.

Air, 53·	Ranunculus,	(shut)	51. 5.
At 8 o'clock p. m. Air 55·	Ranunculus,	(shut)	53·
" 53·	ditto		51.5
" 52.5	ditto		52·
" 51.5	Daisy corolla, half unfolded		51.5
" "	ditto		52·
" "	ditto		51.5
" "	ditto		52·
" 52·	Cowslip,		52·
" 52·	Dandelion,	(shut)	51·
" 52.5	ditto	(shut)	51·

It seems clear, therefore, that the loss of temperature by radiation, is the efficient cause of the shutting of the corolla, and the sleep of plants; and it is also evident, that the electro-chemical solar stimulus is necessary to arouse the dormant resilience of the fibre. So soon, therefore, as the orient beam "flames in the forehead of the morning sky," the crimson-tipt daisy unfolds, and on the declension of the sun-beam. shrouds by the contraction of its petals, the central florets. The nymphea emerges from the surface of the water in the morning, and in the evening sinks again,—a medium of uniform temperature, where the loss by radiation is subdued. Thus, too, is it with its illustrious congeners, the lotus of the Ganges, and the sacred bean of Egypt. These pay their obeisance to the rising orb; and declining, as the sun falls from the meridian arc, plunge beneath the surface of the water, when that luminary sets 'mid the crimson and vermilion grandeur of a western sky. The phenomenon referred to is particularly noticed by Theophrastus, Pliny, and Prosper Alpinus,—and became an emblem of the influences of the sun in Egyptian mythology. Horus, or Aroueris, indentified with Harpocrates, is represented as connected with the sacred lotus, interweaved with hieroglyphic imagery. Harpocrates was placed on the flower cup, with his finger resting on his lip; perhaps intended to adumbrate the silent march of the sun, while the lotus thus became the type of its diurnal revolution.

There are several interesting phenomena connected with the correspondence of colour in relation to elevation and latitude,—to cold and warm aspects and situations.

and to bright and clouded seasons;—there is even something annual and periodic in these modifications and singularities. A little above the point where the pine, &c. disappear on the rocky acclivities which fringe the Missouri, a brilliant vegetation supervenes—the stems of these plants are matted and procumbent—a rich *blue* is the prevalent colour, and there the peristimon erianthera, and the aquilegium cœrulea, are more intense than in the plain. Alpine plants discover a perfect accordance in their livery. It has been remarked by Mr. Sabine, in his communication on the crysanthemum; that the changeable variety in a cold situation, has florets of the purest white, while in a warm aspect and scite, the central florets are purple, and those on the outside white.—During a severe spring, the violet is much attenuated in its dye, and in a wet, gloomy, and clouded season, the red rose never blushes half so deeply, as during warm and genial weather. It occurs to me, that the 'rosa odora,' affords an illustration of this fact: in early spring, the flower displays the faintest shade of red; in summer it brightens, and in autumn evolves its deepest tint. Parallels of latitude have indigenous colours, as prevalent in the decorations of that portion of the terrestrial surface they include, and have their type and counterpart in corresponding grades of elevation. The brilliancy and richer furniture and dyes of tropical plants, their crimson and their scarlet robes, contrasted with the yellow insignia of more temperate climes, and the blues and whites of arctic and antarctic regions, concur to prove the inference just. It is equally interesting to witness the conformity of these to season, and their regular and gradual introduction. The snowdrop, with a vesture delicately emblematic, introduces the flowery train—a drooping bell, that does not lift its eye to a cold and watery sun. In summer and autumn are congregated, in one beauteous assemblage, Flora's richest and fairest forms and hues, while the autumnal crocus, 'orphan of the year,' closes the list in autumn: these exhibitions are all in perfect harmony with the question. Some plants have their petals painted differently on their several surfaces; the blue hepatica is *white* externally, the veronica, and the myosotis scorpioides, or pretty little 'forget-me-not,' are much diluted on the exterior surface of their petals. These may be destined to act, as a counterforte to the radiation, which ever emanates to a bright nocturnal sky. The infant bud of the autumnal crocus, as it emerges from the earth, is *white*: no heat can be spared, for it has obtained none from the illuminated medium; the structure and position of the flower bear also testimony to these conclusions.

On the whole, therefore, I am of opinion, the sensible temperature evolved, is cast off by the electro-chemical action of the sunbeam; that colours have a specific and individual electric character, and in virtue of this, in relation to the solar rays, peculiar affinities of absorption. The amount of sensible caloric, therefore, will be an index of that of the electro-chemical action superinduced. The fact of lightning selecting and seizing on *particular* colours, to the exclusion of others, is very remarkable, and yields a singular evidence in favour of our opinion; thus it has destroyed individual colours in the paper hangings of a room, or those of pyebald or mottled cattle in a field, and spared the rest. There appears to me also to exist a geographical distribution of colour on the surface of the globe, having an electro-magnetic correspondence with isothermal lines, or lines of equal temperature, and this holds good in animal as well as vegetable nature. Thus we have, in tropical regions, the Amhertia nobilis with its vermilion canopy of flowers, and other gay and dazzling scarlet blossomed plants. The yellow crowfoot is a type of our more temperate clime, and the gentiana nivalis and soldanella alpina are representatives of Alpine solitudes, as the snowdrop is of still colder climes. Even the livery of the Alpine hare and arctic fox correspond with our illustrations; a curious subject of enquiry, which might be indefinitely extended.

CHAPTER VI.

Seeds—Peculiar and singular Auxiliaries of Vegetation, Spines, Tendrils, Ascidia, &c.

THE definition of the parts connected with the perpetuity of the plant, as given by Linneus, is singularly felicitous and concise:—" the fructification is a temporary part of vegetables, destined for the reproduction of the species, terminating the old individual and beginning the new."—The curious apparatus connected with the seeds and seed vessels is not the least singular part of the wise adaptation and arrangement of that incomprehensible Being, whose name is WONDERFUL; we cannot indeed turn over a leaf of the volume of the mysteries of creation, without meeting, on every page, evidences of that infinite wisdom which surpasses knowledge. To describe the 'wheels within wheels' of this section of the phenomena of vegetation is altogether beyond the province of human intellect, though we may glance at a few of the parts of that complicated mechanism, which is concerned in the perpetuity of the species. The stamina, as they are called, are commonly walled in by the coloured fringe of the corolla. In a peculiar variety of the crocus, the stamina form officinal saffron. The anthers enclose a subtile powder, which sometimes bursts with elastic force, from the cells which imprison it. This is called by botanists *pollen*, and the distance to which it is sometimes transported through the air is immense. Treviranus observed that the surface of some ponds was entirely obscured by the pollen of wild pines, which grew at a distance of half a league. The most remarkable phenomenon of this kind, however, has been 'married to immortal verse,' by Pontanus, an Italian poet. There are two palms, one at Otranto, and the other at Brindisium: it so happened that these palms have different organs of fructification; and neither carried seed, until, in process of growth, they overtopped the trees of the intermediate forests; the pollen afterwards being wafted through the intervening space, a distance of forty miles, the palm which had the rudiments of the seed vessels then matured its seeds. This subtile elastic powder must no doubt be frequently transported by winds to almost incredible distances. The quantity that may be shaken from the frond of a fern is quite surprising. That of the birch and willow, during inflorescence when the branches are shaken, will rise like vapour. A military officer observed some time ago, what he called a 'smoking plant,' on the Swan River; and we have no doubt such an appearance was presented; but at the same time it would be absurd to suppose that this singular phenomenon arose from any increment of temperature, which could present such an appearance: we are inclined to ascribe it to the elastic diffusion of an extraordinary quantity of pollen from some tree in blossom; in the cypress, for instance, it is thrown out with such force, and in such abundance, as to bear a remarkable resemblance to a cloud of smoke. The cells containing the pollen burst open with an elastic spring, and disperse it into the surrounding air. The yew is diœcious, like the palm, and when the one which contains the stamina, sheds its pollen, the quantity which rises into the air, when the branches are shaken with the hand, or agitated by the wind, is astonishing. Mr. Dovaston, of West Felton, near Shrewsbury, an acute and intelligent observer, has one of the most graceful and beautiful yews I have ever seen; its branches are elegantly pendulous, and it may with strict propriety be called a weeping yew:* he describes it as as 'smoking like a very volcano to the blasts of February,' and which he justly describes in his letter to me, as 'a tree of most striking and distinguished beauty; spreading horizontally all around, to the diameter of fifty-tree feet, with a single spiral leader, to a great height, each branch in every direction, dangling in tressy verdure down to the very ground, pendulous and playful as the most graceful birch or willow, and visibly obedient to the feeblest breath of summer air.' That trees however may be occasionally ignited by lightning, as in the pine forests of Lapland and Sweden; or the friction of the canes among the jungles of India, or the savannahs and forests of America, there can be no doubt; perhaps this may also be occasioned by causes little suspected, as a curious fact may serve to illustrate. The leaves of some cucumber plants were singularly perforated as by the action of intense heat, and the gardener, from some observations I had been making on another occasion, shrewdly ascribed these singular perforations to the rays of the sun, concentrated in passing through the *globules* of water, remaining, after watering the plants on their leaves. Thus converging to a focal point, which, from their spherical form, would be near the globule, they had acted as so many burning lenses, and perforated the leaf. From an attentive examination of these perforations, I feel persuaded that the gardener is right in his conjecture. But though I have mentioned this circumstance, which seems extremely interesting, I am far from supposing that the phenomenon among the vegetation on the Swan River, arose from such a cause, since it may very naturally be ascribed to the sudden extrication of a cloud of pollen from some of the trees;—perhaps cypresses or pines.

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* Though the yew is diœcious or bisexual, this very elegant one is in itself composite: one branch bearing ripe berries, from which Mr. D. has raised several plants. I am not aware of a similar phenomenon; but Mr. Lockhart, in a communication to A. B. Lambert, Esq., dated from Trinidad, 30 April, 1827, mentions a singular fact in reference to the nutmeg. A nutmeg raised at the garden of St. Vincent's, and carried from thence to Trinidad in June 1824, produced male flowers entirely; in June 1826 all the flowers were female, and it subsequently ripened an abundant crop of nutmegs. I do not know that a fact analogous to this of the nutmeg is any where recorded. The yew referred to is not strictly a parallel case.

The forms of seeds are very curious, and infinitely diversified: some are like a horn, a crescent, a shield, or a horse-shoe; others resemble a snail (medicago), or a catterpillar (scorpiurus)—others, again, will be found like a shuttlecock, as the cyamus; all these forms, we reasonably conclude have their design—‘nothing cometh by chance.’ These peculiarities in structure are connected with their preservation, their dispersion, their insertion into the soil, and the depth to which they penetrate, as well as their mode of germination. The feather grass, stipa pennata, is plumed like an arrow, which will preserve the seed in a particular direction; and as soon as it darts down upon the earth, it worms or screws itself into the soil, to a certain depth; when the plume, having fulfilled its office, breaks off, flies away, and becomes the sport of the winds. Though this be a very singular phenomenon, the shuttlecock seeds of the thistle and dandelion afford examples of contrivances of a somewhat similar kind. The seeds of the tillandsia, or wild pine of the West Indies, a parasite on other plants, are supplied with long threads, which have the property of coiling themselves round the branches of trees, and thus become fixed, until the seeds germinate. Many seeds are remarkably susceptible of moisture. The seeds of the musk cranesbill are connected with an apparatus which unscrews itself when moist, and coils itself up again, when dry. When these seeds are moistened they begin to move, and the minute hairs serve as feet to direct their movements. When the bearded oat is left for some time undisturbed in the barn, along with other grain, it is found to have escaped from the husks, and crept to a distance from its former attachment. The grains of equisetum sylvaticum, when placed on a table, and viewed through a lens, present an appearance like insect motion, and may be seen to leap over an intervening object. If we shake a frond, for instance, of the horse tail fern over damped paper; when examined by a lens, the minute seeds will appear to crawl about like so many spiders. Thus the application of the awn of the wild oat for the purposes of hygrometry, and the still more sensible Indian grass, employed in Captain Kater's ingenious and beautiful instrument. The peculiar inclination in the inequalities of surface in the awn of barley, will prevent its retrogression, while its expansion by moisture will impel it forward from the spot where it originally fell: its march onward, therefore, will be incessant from moisture, and it will merely pause in its progress, when that moisture exhales. Mr. Edgeworth constructed an automaton figure on the principle of the animated oat, which, in a few weeks, walked across the room. The screw-like structure of the bearded oat is very apparent, resembling in some measure the remarkable stem of the screw-pine, which is perhaps designed to serve a somewhat similar purpose in its relations to moisture; if we breathe on the seed, the awn, which is a little elevated above the plane of the horizon, will be put in motion, and describe the segment of a circle. When the avena fatua, or mad oat, is therefore moistened, it writhes like a being possessing life; of this description is the seed of the geranium cicutarium, and others. The seed vessel of the didymacarpus rexa, which is twisted up in the form of a spiral coil, unwinds with moisture, and drops its seeds under circumstances favourable to their germination. The microscope reveals some extraordinary phenomena of this kind; and Mr. J. E. Bowman pointed out to me some singularities in minute cryptagamous seeds, which, when affected by moisture, and seen under the microscope, appear all life and motion, particularly the trichia and sphœriobolus, where, from a point, invisible to the unaided eye, the seed vessel voluntarily expands, and rolls forth its millions of globes, as indeed its name in Greek implies.

The dispersion of seeds also supplies us with a chain of curious contrivances, admirably suited to the purposes for which they are designed; and it is a subject of regret, that these singularly constructed species of mechanism, have not been so minutely investigated, as the interesting subject merits; well might Forskal say; "miro, nec adhuc investigato mechanismo propelluntur semina." The capsule of the violet will project its contained seeds to a distance of several feet; and the elastic arillus of the wood sorrel, will eject them over a considerably greater space. The euphorbia coccum (Gærtner) is also remarkable in this respect, as well as some of the ferns, which possess an elastic ring for the purpose; geranium, fraxinella, and others. The crackling of the capsules of furze in a warm summer day must be familiar to many, and is sometimes the only sound which breaks the stillness of the landscape. The scales which enclose the seeds of pines sometime open suddenly, and disperse their contents. The noise occasioned by this mechanical impulse on the air may be often heard at a considerable distance: "This crackling voice," says Mr. Keith, "was observed and traced to a fir-tree, namely pinus pinea, at Kendlesham parsonage, on July 14, 1808, by two young gentlemen, my pupils, who thought the tree was bewitched till the cause of the noise was pointed out to them." A species of wild cress, cardamine impatiens, suddenly unfolds its seed vessel, on being touched. I have, when handling the plant, and more minutely examining the structure and elastic apparatus of the seed vessels, been temporarily deprived of vision, by the impulsion of the seeds into my face. The balsam, balsaminum, is not less curious than the rest of these, and has been not inappositely, from the elastic force employed by the seed pod in the dispersion of its contents, called 'touch-me-not.' In these cases, the power of the projectile seems to reside in the elasticity of the valves of the capsule.

The mechanism of the seed vessel of the spirting cucumber, momordica elaterium, is however altogether different; it is a tube unsupplied with valves, and the seeds seem to be projected from it, like the ball from an air gun, by the sudden extrication and expansion of elastic matter. "On the slightest motion," says Dr. Walsh, "these capsules detach themselves, and shoot out all their seeds with considerable force, so that a passenger is frequently struck in the face by merely walking by the plant:" and according to Pliny, "etiam oculorum periculo." I am inclined to consider that the electricity of the plant may have to do with this singular phenomenon, and that it may resemble an electrical experiment, sometimes repeated with a drop of ether, which, being expanded by the electric spark, serves to propel a cork ball from the orifice of a small mortar; unless we can suppose a sudden evolution of heat sufficient for the purpose. The capsule of the sand box tree, hura crepitans, so called from the use to which it is sometimes applied, appears to be affected by similar principles; it bursts with a noise as loud as a pistol, and often sufficiently startling. To causes similar to these, as connected with the wonderful physiology of plants, we may satisfactorily ascribe the mysterious sounds, sometimes described as being emitted from trees.

The seed vessels have often a curious, and sometimes a beautiful form, as may be exemplified in that of the sand-box tree; also the capsule of the yellow water lily, nuphar lutea. The seed vessel of the poppy somewhat resembles a Roman urn, and, conjoined with its soporific properties, may have suggested its form. The skeleton of the papaver orientale is very beautiful: the skeleton capsules of the hyociamus niger and astrantia major are also curious and elegant. The figure is that

of a skeleton capsule of the nicandra phasalides. The seed pods of the bladder senna explode with a loud noise on their sudden pressure.

The arillus, or seed coat, is sometimes beautifully coloured. That of the nutmeg, known under the name of *mace,* is an example of the arillus. In the afzelia it forms a scarlet cup; and in the spindle tree, euonymus europæus, the seed coat is a rich orange, and has a very curious and uncommon effect, when it is displayed by the opening of the differently coloured capsule. Dr. Walsh mentions a variety of the euonymus europæus the arillus of which is a bright scarlet. In a species of mimosa, the black seeds are imbedded in a farinaceous powder of a fine yellow colour, used as food by the natives of Africa. In the lotus of India, the seeds are viviparous, or sprout out in the capsule, which then exhibits a complete cornucopia of young plants, finally dispersed on the waters, to shift for themselves. The alium arenaria sometimes exhibits the same phenomenon after it has been laid aside for some time. Some seeds are extremely delicate, susceptible of change, and require to be managed with skill and dexterity. The seeds of the trapa natans, we believe, must be directly received into water, a condition necessary to their germination. Dr. Walsh observes, in a communication to the Horticultural Society, that the seeds of one variety of the cucumis melo are so delicate, that they were delivered to him in a sealed bottle, with strict injunctions that it was not to be opened, until the period of their being sown, lest 'the essence should evaporate.' The seeds of the club moss, lycopodium clavatum, are singularly inflammable. This powder is employed in theatres to mimic lightning, and enters into the constitution of Chinese fire-works; the Chinese being quite celebrated for their skill in pyrotechnics. It is also employed by the apothecaries of Germany as a substitute for magnesia or liquorice powder in the formation of pills.

Some seeds are highly odoriferous, of which the tonca bean is a familiar instance, and this seems to proceed from the presence of benzoic acid, crystals of which have been found within the seed pod. Something of this kind is no doubt connected with the holcus odoratus to which the fragrance of new made hay, is attributable.

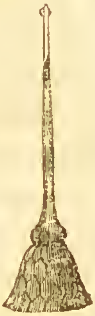
Not the least wonderful phenomenon connected with seeds, is the very singular one of plants—*planting their own seeds.* Some plants literally do this, nor part with their seeds, until they are safely lodged in the earth. The arachis hypogæa, an annual stove plant from America, by means of the spiral coils which clutch the seeds, burrows in the earth, and there buries its seeds to ripen and to vegetate. Of a similar kind I have noticed are the spiral stems, which bear on their summits their respective seeds, in the case of the sowbread, particularly that beautiful species, the Persian cyclamen, and the narsturtium, in both of which I have discovered the same inclination, and have in some cases found, where the earth was made soft and sandy for the purpose, that they buried their seeds in the soil, before they parted with them. The autumnal crocus ripens its seeds entirely below ground, producing a phenomenon that adds a singular feature to the physiology of the plant. This plant is quite remarkable for the tedious ripening of its seeds, as well as their deep lodgement in the earth. The flower is displayed in autumn, and the tube which connects it with the seed vessel is very long, proceeding immediately from the bulb in which the germs of the seeds are imbedded, and in the month of March or April the seed ripens: the capsule containing them afterwards shoots above ground, supported on a foot-stalk, and accompanied by the leaves; so that it presents to the common observer, unacquainted with its singular physiology, seeds formed and perfected, before the flower.

We now pass to the consideration of some remarkable attachments, all of which, though outrivalling those most familiar to us, are essential and necessary to complete the conditions to be fulfilled by the plant with which they are connected. In creation, we hold that there is nothing superfluous, and nothing made in vain. This position is as obvious as that two and two make four. That the end and object may not be always seen, does not affect the position. The most intelligent and gifted mind will be often at bay; but, reasoning from what we know, the inference is a just one; because in what we know, there are facts which prove it, and the more we advance forward in the path of knowledge, the more perspicuous and evident is the design; and the more wonderful does the adaptation seem.

Glands are of various forms, and variously placed: sometimes they are found within the flower, and are recognized, in several cases at least, as nectaries. In the crown imperial, the cups replete with honey, are very imposing; and in that beautiful flower, the hoya carnosa, the drops of pure honey which distil from its velvet like surface, imparts a singular character to it. In many instances, these nectaria are a curious and elaborate apparatus, as in the parnasia, where they are beautifully fringed, and aconite; but these glands are not confined to the flower, they are found on stems and leaves. The foot-stalks of the passion flower secrete honey from glands. Viscid matter exudes from the flowers, as well as leaves of many plants. I have seen immense quantities of dead flies attached to the exterior of the flowers of the erica tricolor. The catch fly is of the same kind; the drosera rotundifolia has its leaves supplied with glandular hairs, which secrete a viscid matter that entangles flies. The leaves of the roridula dentata, a Cape shrub, are employed by the natives in their houses to entrap flies. Sometimes these glands are in the form of little cups; sometimes they are supported on short stalks; occassionally they resemble scales, and at other times are delicate tubes in the form of hairs. In the foot-stalk of the nectarine leaf, the gland resembles a shallow cup, elevated on a stand; in the drosera rotundifolia it is also crateriform, supported by a foot-stalk; it is branched in the moss rose, and forms one of the loveliest ornaments of that queen of Flora's court. A German writer sports a beautiful idea on the moss rose, and it has been transferred to English verse: though the picture is fanciful, there is an unusual elegance in this garland of poesy to justify its transcription in this place.

The angel of the flowers one day,
Beneath a rose-tree sleeping lay,
That spirit—to whose care is given
To bathe young buds in dews from heaven;
Awaking from his light repose,
The angel whisper'd to the rose:
'O fondest object of my care,
Still fairest found where all are fair,
For the sweet shade thou'st given to me,
Ask what thou wilt, 'tis granted thee.'
'Then said the rose, with deepen'd glow,
'On me another grace bestow.'
The spirit paused in silent thought,
What grace was there that flower had not!
'Twas but a moment—o'er the rose
A VEIL OF MOSS the angel throws,
And, robed in nature's simplest weed,
Could there a flower that rose exceed."

The varieties of the moss rose are now numerous, and all of them are beautiful. I have the single moss, scarlet moss, white moss, and blush moss roses, as well as the mossy rose de meux: a mossy China rose has been introduced more recently from France, but I have not seen it. Sometimes the bristles, (setœ) as well as hairs, are excretory ducts connected with glands, as in the nettle. In the nettle and loasa, these bear a strong resemblance to the poisonous fang, and poison sacs of serpents. In the nettle, the tips of the setœ, when pressed, exude a clear liquid matter, which flows from the secreting sac or gland below, with which it is connected. The difference between the poison fang of serpents and these, in point of structure, is, that in the latter case the poison flows from the tip, and in the former from a lateral opening, from thence introduced by a sulcus into the wound, inflicted by the fang. Mr. Curtis removed this liquid matter from the nettle, and introduced it into the skin by a previous puncture, when inflammation followed. The figure is that of the loasa nitida of Chili, an annual, now sometimes raised from seed in our gardens. In this case, the lower part is the sac where the poison is secreted, the tube is hollow, and is the duct through which the poison flows when the part is wounded; the tube being pressed back upon the poison sac, by the resistance it meets with, causes the ascent of the poison, and its injection into the wound. Great caution is necessary in handling this plant; and, in the case of children, the consequences might be serious. The recovery from it is much more tardy than from the wound inflicted by a nettle. The bristle of the malpighia urens is very curious: it lies horizontal, or parallel to the leaf, and presents a hollow spindle shaped appearance, supported by a very short foot-stalk. Thorns and prickles are sometimes simple, sometimes complicated, in particular cases they are more or less curved, and at other times perfectly straight. The furze, hawthorn, and holly, are familiar instances of this kind of armature; the rosa spinossissima is singularly bristled, and well guarded by this prickly armour. In the gleditschia triacanthos, there is a treble



combination of formidable thorns: and in one of the same genera of plants in the South of Africa, the tree is clothed from top to bottom with double thorns, from five to six inches long. Indeed, in one of my own plants, gleditschia horrida, these thorns are sufficiently formidable, but they are single, measuring three to four inches in length, and very strong, much more so than in the gleditschia triacanthos. I am informed that where these are indigenous, birds are sometimes found impaled alive by accidently flying against them. In these kinds of mimosa are often presented a defence altogether impenetrable to the attacks of wild beasts; the rhinoceros alone excepted, whose coriaceous skin is proof against shot, and from which the musket ball recoils. The butcher bird impales his victims, such as beetles, on the thorns of trees. The Cape asparagus, asparagus capensis, possesses remarkable recurved thorns, so that it is impossible for any one to make his way through such a thicket: it tears the clothes of the individual who ventures the ordeal; and Thunberg says, the natives call it wakt en beetje; 'stop a bit.' Mr. Burchell gives us a curious account of his adventure with what he calls the 'hook-thorn,'—'I was preparing to cut some specimens of it, when the Hottentots warned me to be very careful in doing so, otherwise I should certainly be caught fast in its branches. In consequence of this advice, I proceeded with the utmost caution, but with all my care, a small twig caught hold of one sleeve; while thinking to disengage it quietly with the other hand, both arms were seized by these rapacious thorns, and the more I tried to extricate myself, the more entangled I became, till at last it seized hold of my hat also, and convinced me that there was no possibility for me to free myself but by main force, and at the expense of tearing all my clothes; I therefore called out for help, and two of my men came and released me, by cutting off the branches by which I was held. The pterolobium lacerans is a bushy shrub, from six to eight feet high, found in Abyssinia, its foliage is pinnated, and the thorns are formidable, so much so as to oppose the progress of an army. The skins of animals are alone proof against such a barrier; and the royal edict which precedes a march is couched in terms sufficiently concise,—"Cut down the kantuffa in the four quarters of the globe, for I do not know where I am going." A kind of hook attached to the lid of the nepenthes distillatoria, serves to preserve the pitcher in an upright position. The flower stalk too of the annona hexapetala forms a hook which grasps the contiguous branch, and serves to suspend the fruit, which is very heavy. In these provisions we trace the most remarkable design: some trees are only clothed in this armour when young, and defenceless, as the silk cotton tree,—and in the holly, this armature only extends as far as is within the reach of cattle, while all above is thornless.

Tendrils are peculiar parts which belong to the possessions of plants; and they are intended as means of support; hence, weak and pliant stems, which require such support, are supplied with tendrils: by this term, however, we do not mean the peculiar claw-like attachment, by which the ivy fastens itself to the wall, and enables it to creep upward, and veil the venerable ruin by its foliage; imparting to the mouldering mass a chastened interest and beauty: this seems a root-like evolution; but does not supply its place. The scarlet runner, convolvolous, hop, vine, and others, afford examples of the tendril: the plants to which they belong, by means of them, sometimes attain an immense altitude; thus the vines in Crete ascend to the summit of the loftiest planes, which exceed seventy feet in height. Sometimes the tendril exhibits here and there, as in the passion flower, compressed coils, which seem designed by their elongation from moisture, and vice versa, to prevent any strain on the stem, from casual circumstances or the progress of growth. The climbing buckwheat, which has a twining stem, invariably turns in one direction. The convolvolous and scarlet bean appear to turn in the direction of the apparent motion of the sun. The hop turns the contrary way; and what is still more singular, any attempt to reverse these directions proves injurious, if not entirely destructive to the plant: in the marsh-mallow-leaved hermannia, there appears the singular phenomenon of two flowers on the same stem, the one being turned in the opposite direction to the other: the stems of these flowers are spiral. Voluble stems require no tendrils, because the entire stem acts as one continued tendril. Tendrils perform the same office as these stems: while the latter coil round the support, the tendrils clutch its branches, and prevent the plant from falling to the ground. The tendril issues sometimes from one part of the plant, and sometimes from another: in the gloriosa superba, it comes from the tip of the leaves: sometimes, though rarely, the tendril, after having made a certain number of revolutions, in one direction, turns the contrary way. The modified tendril, in the Virginian creeper, emerges from the axillæ of the leaves: it is branched and spiral, and can indiscriminately fasten on a bare wall, or clutch the branch of an adjoining tree. Calandrini found that vine leaves, when entirely separated from the plant, attached to a string, turned their leaves to the light: and it appears to me likely that the tendril may, in many instances effect some such purpose in the stem or foliage. A spiral coil, twisting and untwisting, as variously acted on by heat and moisture, might not only elongate a leaf or flower, the foot-stalk of which is spiral, but turn the leaf or flower toward the sun, at whatever angle of elevation might be required, whether east or west. By simple means like these, do plants, in themselves feeble, and liable to destruction from every casualty, ascend to the top of the loftiest tree, and crown them with an adventitious show of foliage and of flower.

There are other follicular attachments of a still more remarkable character than these. The trap, which forms a prolongation of the leaf in the dionæa muscipula, will be considered in a subsequent chapter. Bladders, attached to some aquatic plants, give buoyancy to their stems and leaves, particularly observable in some sea weeds; aldrovanda vesiculosa, and the utriculariæ, exhibit these vesicles. The conferva bullosa receives its specific name from the small bladders which preserve its buoyancy.

There are, however, two remarkable folliaceous adjuncts which belong to vegetation; one of these is simply connected with the structure or form of the leaf, the other is a distinct appendage to it: these are pouches and pitchers: the first belong to the sarracenia, and the latter to the nepenthes distillatoria, and cephalotes follicularis: the physiologies of these have been jumbled together, though they are essentially distinct: in the first, the pouch is a tank which holds the supply it receives from the atmosphere, whether in rain or dew. This water may tempt the insect to descend into the deceitful recess, when it becomes the victim of its temerity, and its decomposition may afford ammoniacal effluvia, necessary, perhaps, to sustain and nourish the plant: it is certain also, that some plants give off ammonia, as in the case of chenopodium, as determined by M. Chevalier; but in the case of the pitcher plant, nepenthes distillatoria and cephalotus follicularis, the phenomena are altogether unconnected with insects, and the atmosphere; because the liquid contents of these ascidia or pitchers, are distinct secretions of the plant; nor does the lid in the former ever open until the pitcher has completed its office; after the lid begins to open, it never shuts again, and before the period of its evolution, it is hermetically closed.

The leaves of the sarraceniæ are pouches, somewhat resembling, in form, the finger of a glove: the sarracenia flava and purpurea, are hardy, and grow among the swamps of the United States of America, as their indigenous habitats; the sarracenia adunca is more tender: in the sarracenia flava, each leaf is a hollow cylinder, capable of receiving and retaining water: a partial cover in the form of a leafy attachment excludes, in the first instance, rain and dews, but when fully exposed, the pouch collects both: in this water may be discovered a great many dead and dying insects, which are prevented from escape by the setæ or bristles, which line the interior of the pouch, and all of which, point, like the wires of a mouse trap downward, so that the descent is easy,—"facilis descensus"—but the return is difficult: the gorge of the sarracenia being bristled with down, inclined inwards, will certainly prevent the escape of the insect; but the stupefactive properties of the water, perhaps impregnated with ammoniacal matter, arising from the decomposition of animal substance, may also suspend, as observed by Dr. Macbride, the activity of the insect, and it thus falls down into the water, at every attempt to escape: in the common arum, I have found numerous dead insects, and several evidently under an opiate influence: as many as 18 insects have been counted in one pouch, chiefly the musca domestica, and musca vomitoria, becoming a complete trap and tomb; the scent of these indeed is sometimes sufficiently sensible as we pass the plant. Sir James Edward Smith has the following observation in consequence of a communication made to him in the Liverpool Botanic Garden. "An insect of the sphex, or ichneumon kind, as far as I could learn from description, was seen by one of the gardeners, to drag several large flies to the sarracenia adunca, with some difficulty forcing them under the lid or cover of its leaf, to deposit them in the tubular part, which was half filled with water; all the leaves, on being examined, were found crammed with dead or drowned flies:" but though the sarracenia flava and adunca have covers, they only fit partially; are imperfect, even in them that contain water, and this can scarcely be considered as secreted by the plant. In the sarracenia purpurea, the leaf which partially projects over the mouth of the pouch, cannot serve the purpose of a cover, and to us seems rather a kind of trap-board, from whence the heedless insect may tumble into the water below: this view seems to be in some measure corroborated by the observations of Dr. Macbride, of South Carolina: flies attracted to the leaves, first alight on the faux of the pouch, and seem eagerly engaged in sipping the sweet matter secreted from the glandular band: "in this position they linger; but at length, allured as it would seem by the pleasure of taste, they enter the tube: the fly which has thus changed its situation, will be seen to stand unsteadily, it totters for a few seconds, slips and falls to the bottom of the tube, when it is either drowned or attempts in vain to escape against the points of the hairs:" it is highly probable that in the case of the dead insects tumbled into the sarcophagus of the sararcenia adunca, by the ichneumon, they were insects in which it had already deposited its ova: this seems probable, from the circumstance of living larvæ having been noticed by Dr. Macbride—the spider and moth can, however, escape from these vegetable reservoirs.

The cephalotus follicularis, is a plant discovered in Australia, by M. Labillardiere, and, subsequently near the shores of Princess Royal Harbour, in the neighbourhood of King George's Sound, in the same quarter, by Mr. Robert Brown. This curious attachment is intermingled with the foliage of the plant, encircling the base of the flower stalk: it is egg shaped, about an inch long, and supplied, as in the nepenthes distillatoria, with a lid; the lip is also supplied in the same manner, with a ring. The inside of the pitcher is shining and of a beautiful dark purple colour: it is highly probable that the liquid contained in the pitchers of the cephalotus follicularis is a vegetable secretion, and it is somewhat saccharine. No doubt, the lid is opened in process of time, by the advancing maturity of the parts associated with the pitcher: the mechanism immediately connected with this process, is the spiral coil on the lip of the ascidium. Mr. Brown observes, that the pitchers were "in general half filled with a watery fluid, in which great numbers of a small species of ant were frequently found drowned: this fluid, which had a slightly sweetish taste, may possibly be, in part, a secretion of the pitcher itself, but more probably consists of rain water received and preserved in it:"—why not *altogether* a secretion, seeing it is admitted, that in the full grown state, the operculum of the pitcher was "found accurately closing its mouth?" In the nepenthes distillatoria, there can be no scepticism entertained on this point, by any one, who has observed the plant with the requisite degree of attention. It may be further added, that the cephalotus differs from the nepenthes in this: the ascidia in the former have distinct foot-stalks, and the leaves and pitchers are formed in a tuft: the flower scape is leafless, and the entire plant about 18 inches high: in the nepenthes, on the other hand, the pitchers have an intimate connection with the leaves, and constitute a distinct prolongation of them.

The nepenthes distillatoria, represented in plate I. figure 3, is among the most extraordinary of the wonders of vegetation. This remarkable plant is found in Ceylon, Java, and other countries of the east. In Amboyna and Java the nepenthes is found on dry and elevated situations; but in Ceylon is said to be met with on the verge of streams in vallies. Its foliage is adorned with elegant pitchers, or ascidia, which contain a limpid fluid, that may be used as a beverage: to these leafy cisterns, it is said, monkeys sometimes resort, to quench their thirst; hence the name sometimes assigned to these vegetable reservoirs—'monkey cups;' and from the impressions of the teeth and bills of animals and birds, at times found on these pitchers, it is highly probable they are frequently resorted to by the tenants of the woods. Mr. Barrow, in his description of Cochin China, makes some remarks on this curious plant, the greater part of which is entirely fabulous; as any one may be satisfied of, who has accurately investigated the phenomena. Though the remarks about the opening and shutting of the lid to receive rain or dew, and prevent evaporation, is a mere fable; the opinion has been adopted and perpetuated by repetition. Some of his other remarks, however, are more to the purpose, and seem correct. The pitcher, he observes, is of the same colour as the leaf, and subsequently changes to a reddish purple. It is girt by a hoop, or band, and has a lid moveable on a hinge, formed by a strong fibre. When the plant has matured its seeds, &c., and the dry season sets in, these appendages wither, leaving their lids open. I have had the opportunity of particularly examining and investigating the remarkable physiology of this extraordinary provision in vegetation, in some plants in the royal botanic garden of Edinburgh, and Professor Dunbar's hothouse; together with the botanic garden at Hull. That of the royal botanic garden is a remarkably fine and tall plant. The nepenthes is diecious; if we mistake not, however, it has ripened seeds in the Edinburgh botanic garden, and young plants have been reared from those seeds, from the introduction of Professor Dunbar's plant into the same hothouse. The ascidium, or pitcher, is a prolongation of its lanceolate leaves, and so far there is a distinct correspondence between the dionæa muscipula and the nepenthes distillatoria. The liquid is, beyond doubt, secreted through the mid rib of the leaf, which, by careful dissection, I found to be a *hollow canal;* and in it traced a portion of the same liquid which was flowing into the pitcher. In all the pitchers this liquid is invariably found, and is observed long *before* the lid begins to open. I found the lid so closely united, and, if I may be allowed the expression, so hermetically sealed, as not to be separated but at the expense of lacerating the leaf; so that neither liquid, or elastic matter, could in the previous instance find admission into the pitcher: moreover, after the lid of the pitcher has begun to open, it continues so, and never shuts afterwards: insects, it is true, I have seen in those pitchers, but this was entirely a subsequent affair; the liquid had been reduced by evaporation, and the lid had been some time open. When animals repair to these vegetable cisterns, they must needs tear open the lid to get at their contents, and that this is the case there is sufficient evidence. Sir James Edward Smith was therefore perfectly correct, in inferring that the liquid is "certainly secreted by the foot-stalk of the leaf." Rumphius says, no insect is capable of living in these ascidia, except a small deformed squilla, or shrimp, which lives there. The chemical examination of the liquid gives countenance to this opinion; and as for the shrimp, it can only gain access into the pitcher by perforating it, or waiting till the lid opens in the progress of vegetation. My observations, however, secure my assent to the observation of Rumphius, that the waste by day, which he says amounts to one half, is repaired at night.* The rise and fall of the liquid in the pitcher, I have certainly noticed, and this too before there had been the slightest evidence of the opening of the operculum. It may be observed that there are various species of the nepenthes, and their pitchers vary considerably in capacity; some being of sufficient size to hold a pint of liquid. Figure 3 of the plate gives a correct representation of the pitcher, which is curiously ribbed, somewhat protuberant toward the lower part, and in some specimens, that I have seen, singularly elegant in form: there is a loop in the connecting foot-stalk, between the pitcher and the leaf, properly so called, of which it forms a part: the middle rib behind, and toward the hinge, carries a singular hook, of a very neat form: the lid is a flat heart-shaped leaf, supplied with a joint, or hinge, within the rib, which forms the hook in question. The spiral ring of the lip of the pitcher is the most curious of all: it resembles a coiled wire, or spiral spring, parted at the centre, in the front of the pitcher; and its extremities press on each side of the articulation of the hinge. Dr. Edward Turner is stated to have obtained from a pitcher of the nepenthes distillatoria, sixty-six grains of a liquid which had a "subacid taste," and yielded, when evaporated, "minute crystals of superoxalate of potassa." This analysis differs most essentially from my own. I submitted to a most careful analysis a portion of the liquid, taken from an unopened pitcher on the plant already mentioned, in the Edinburgh botanic garden, in April, 1829. The temperature of the air and the liquid was 80° F., and my chemical analysis of it yielded me the following products:—Protocarbonate of iron, supercarbonate of lime, sulphate of magnesia, and muriate of soda. I infer the presence of muriate of soda, from the chemical action of nitrate and sulphate of silver. The presence of *lime* was indicated by a crystal of *oxalate of ammonia,* as well as that of oxalate of potassa, in the production of a white nebulous appearance; a phenomenon utterly *incompatible* with the presence of oxalate of potassa. I inferred that this was a supercarbonate of lime, from litmus paper being unaffected, while turmeric paper was reddened, and Brazil paper remained unchanged. I also deduced the presence of protocarbonate of iron, from the phenomena presented by the effect of tincture of galls being accelerated by the pre-addition of limewater. The presence of a sulphate, and of magnesia, were determined by nitrate of baryta, and phosphate of soda, &c.

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* "Hæc sensim minuitur usque ad dimidiam partem, ita tamen ut per noctem iterum adcrescat tanta copia, quanta per diem fuit exsiccata:"—*Rumph. Amb. L.* VII. *Chap.* 61.

I examined a pitcher with great care, accompanied by the lens: it was 4¾th inches deep: the spiral rings of the lip are continuous, connected by a membrane, and toward the hinge a separation takes place. These rings gradually expanding in the progress of growth, force open the lid at the hinge, by impinging against it, the centre in front, being the *fulcrum:* the spiral lip becomes broader as we approach the articulation of the hinge. The body of the pitcher is composed of parallel ribs or costæ; arranged vertically; and a reticular membranous veil or film overspreads them. Two parallel plicæ, or dorsal folds, run along the entire length of the pitcher: the lower part of the ascidium is somewhat ventricose, or bulging, becoming narrower towards the neck, or throat: the protuberant part of the pitcher measured two inches in depth, and it is worthy of special remark, that this *portion only* is lined with a shining or varnished shagreen-like surface, completely studded with *orifices,* disposed in close array, over the entire surface, and inclining downwards. There can be no doubt that these orifices are connected with the numerous spiral vessels, which are thickly interwoven with the tissue of the pitcher; and when the membrane is torn asunder the appearance resulting from these numerous spiral filaments resembles a web of gossamer. In every pitcher, I have examined, the secreted liquid of the interior has not exceeded in quantity that required merely to fill the lower varnished portion of the pitcher. The stem, or foot-stalk, which connects the pitcher with the leaf, is a hollow pipe, through which the secreted liquid flows into it; and from which it is re-absorbed by the stomata or mouths which stud the varnished surface of the pitcher; the interstices between these orifices being impervious to any absorption. It is thus that the circulation of the plant is completed by another channel. The excess which may be elaborated, above the requirements of the plant, is, in process of time, decanted from the pitcher, previously supported in a vertical position, by the hook, which has laid hold of some adjoining branch, or the loop of the foot-stalk,—but the hook being now detached from its hold, by the opening of the lid, the pitcher declines from the perpendicular, pours its contents upon the ground, and forthwith the pitcher withers:—" The pitcher is broken at the fountain."

Goethe imagined that a flower was a compound of of metamorphosed leaves; and others, as wildly, imagine that a flower and its stem, are merely a stunted branch.

Lamarck also contended that animals framed their own forms and organs. Many English naturalists, we regret to say, who ought to know better, have adopted opinions not far removed from these insane rhapsodies—such senseless whims we may safely consign to "the tomb of all the Capulets," as alike repulsive to reason and sound philosophy. The singular auxiliaries of vegetation, already described, have been provided by infinite wisdom, because they are required, and are essential and necessary to complete the plant. As a constituent of vegetation, they enter as distinctly into its economy as the root, leaf, or flower, and are as important desiderata as the individual members of any animal in existence. Whatever others may do, and however they may wish to turn things upside down, as for myself, I shall obey the precept of Newton, and "reason from the phenomena up to God."

CHAPTER VII.

Phenomena of Germination——Vitality of Seeds, &c.——Modern Speculations—Ascent and Circulation of the Sap.

When a seed is committed to the earth it absorbs moisture, expands, and meanwhile evolving carbonic acid gas, bursts from its imprisonment, into the form and comeliness of the infant plant. The germ of the root shoots into minute ramifications, and these separate again into other filaments, still more delicate; they serve finally to fasten the plant in the soil, and are the absorbent canals, which transmit the fluid materials essential to the support, well-being, and growth of the plant. The plumula, or little feather, is an advanced stage of what is termed in the first instance, the corculum, from a supposed resemblance to the interior structure of the walnut: this plumula rises above the surface of the ground, becomes, in process of time, a stem, which bears its branches and its buds, and is at length arrayed in leaves of green, and decorated with flowers and fruits. Nothing can be more wonderful than all this. In the seed, in some instances, as in the ash key, we can discover the rudiments of the young plant, as well as in the bud and bulb, as that of the horse chesnut, and the hyacinth; but in the majority of cases, even with the assistance of the microscope, we can discern no tangible vegetating form within the folds of the seed. In the case of the dicotlydonous bean, part of this remarkable process, in an advanced stage, is unveiled. The testa, or skin, is rent by the expansion of the parts within, and cast off; the cotlydons, thick and juicy, open on a hinge, and display the infant bud: the corculum pointing upwards, and the fibrils ramifying on the inner surface of these valves. The cotlydons, composed in the first instance of fecula, or starch, become chemically changed in their constitution, they are converted into saccharine matter, and thus a substance comparatively insoluble, is transmuted into one eminently soluble. This seems to be the earliest food of the young plant, and the remarkable change is simultaneous with the first evolution of vegetation: this metamorphosis is indeed a chemical one, and may be repeated by the action of some acids on fecula, as in the experiments of Kirchoff and others. In the case in question, however, the dormant powers of vitality must be roused for this purpose; and until this period, the fecula of the bean remains precisely as it was. This process is beautifully, and at the same time familiarly exemplified in the process of malting: the barley, after it as been for some time in the 'steep', is removed and spread on an earthen floor. Here an incipient vegetation takes place, accompanied by an increase of temperature, and when the advancing plumula, called the acrospire, has advanced two-thirds the length of the barley corn, the process is checked by the barley being transferred to the kiln. It is the saccharine matter which has been elaborated, that imparts the susceptibility of fermentation to the malt, and this again being fermented, of producing an ardent spirit by distillation. A similar process goes on in monocotlydonous vegetation. In the cocoa nut, the milk is sweet and saccharine, and seems elaborated by some process previous to germination; the interior of the shell is lined with a layer of albuminous matter, possessing a firm consistency, and there is moreover, a sweet milky liquid: the shell is imbedded in a matted fibrous envelope, covered with a membrane. I have had it in my power to examine a great many, amounting even to several dozens of germinating cocoa nuts, and the phenomena are equally interesting; the plumula bursts from one of the eyes, the roots in the mean time spread over the exterior surface of the nut, and completely invest it: if the nut be now cut asunder, a globular mass, white, and of a spongy texture, will be seen at the roof; this increases in size, swelling gradually in magnitude until it entirely fills the shell, the liquid contents of which it absorbs, and finally bursting the shell, is indebted to the earth for its future sustenance. The developement of these mysterious phenomena, are all subordinate to the silent agency of the vital principle, which, like its ALMIGHTY AUTHOR, 'no man hath at any time seen, neither can see:' they are watched with intense admiration by the philosopher, and this period is to him full of wonder, and rich in interest. The mysterious veil which conceals the adytum, where these phenomena are at work, no man may rend asunder: the final products and results however, are the legitimate objects of his skill and cunning. I would not check a reasonable curiosity, or damp the ardour of research; but, the knowledge of "what is doing on the other side," seems to be for ever shut by that key which alone hangs at the girdle of infinite Wisdom. Sound philosophy pretends to no infallibility. Reason, properly so called, does not venture to circumscribe that knowledge which is without limit, and, like the Riphean mountains of antiquity, recedes indefinitely as we advance. There is a certain boundary to the province of genuine science; and it has been rightly observed by an acute reasoner—"The Savage sees God in the operations of nature, and he simply adores: the pseudo-philosopher sees himself in them, and goes about to frame hypotheses in which he attempts to mould their phenomena to his own similitude." The conditions that are necessary to the phenomena of vegetation, with the results of the processes of the vital principle, the existence of which we must unconditionally stipulate for, severally become the proper subjects of scientific investigation.

For the phenomena of vegetation, the presence of atmospheric air will be found essential, or at least is generally necessary to its healthy functions and luxuriance. In this section, we shall take a general view of the subject, referring to a subsequent chapter for some remarkable eccentricities of vegetation. If seeds be deeply buried, their vitality is suspended, though certainly not destroyed. They may rather be considered as hermetically sealed up, for as soon as the soil is pulverized, and they are either raised nearer the surface, or brought into more intimate contact with atmospheric air, and the temperature and electricity of the sunbeam, the vital principle starts from its long repose, and a plant, clothed in a vesture of green, issues from the earth.

Nor is it possible to assign a limit to this prolonged torpidity; as in the egg, so in the seed, the period may be indefinitely extended. Bromare discovered eggs in a wall, still fresh, after the lapse of many centuries; and seeds, and their counterparts, may sleep for ages, in the deep recesses of the earth. It is the present fashion to impugn the fact of toads and lizards being found alive in the heart of the solid rock; from the mere difficulty of accounting for the prolongation of the existence of the vital principle, under such circumstances; and deduced from some experiments that appear to me to warrant no such conclusions. These experiments are not merely inconclusive, but seem scarcely entitled to attention. Let the dormouse, marmot, tortoise, or the Canada jumping mouse, when in a state of complete torpidity, be hermetically sealed up in clay, or other plastic materials. If such were buried a considerable depth in the earth, and examined after the lapse of many years, the results would be worth attention; but in the cases that have been recently brought forward, the proof altogether fails. The question, however, has at present much of the complexion of what involved the phenomena of meteoric stones; their fall from the atmosphere being once stoutly contested, on the same principles: the advance of more enlightened and particular observation will achieve for this phenomenon, what it has done for aërolites. In the mean time, the assumption of a cranny, or a crevice admitting air, &c. to the ovum, or the tadpole, cannot perhaps be met by a flat and positive contradiction. I confess it appears to me, however, more difficult to conceive by what means the rock should have expanded and moulded the cavity into the form of the imprisoned reptile, than that this cavity should have "grown with its growth." It is, however, by no means difficult to conceive of the reptile being imbedded by the soft and plastic rock, and the latter becoming finally indurated, while the reptile, in a state of torpidity, has outlived the lapse of ages. It is merely a wonderful prolongation of the same phenomenon which annually occurs in torpid animals. When we investigate the torpidity of the dormouse and marmot, and consider the absence of pulsation, the decreased temperature, and even the suspension of the functions of the skin and respiration, the phenomenon is not so incredible, as a cautious and sceptical philosophy would lead us to believe. By a calm attention to the numerous facts of this kind, which we have seen recorded, and gleaned from individuals who have witnessed similar facts, we think that they are altogether indisputable; nor can we doubt that in many cases they are antidiluvian animals: animals that had lived in the antidiluvian, and have since survived in the postdiluvian world. With the greatest care they will be found extremely short lived—a few hours perhaps, but at any rate they sustain only a transient existence.

The curious question involved in these preliminary remarks, seems intimately connected with the dormancy of seeds, and their extremely prolonged torpidity; and if it be denied in the one case, we cannot see with what show of reason, it can be conceded in the other. Seeds that had reposed nearly a century between the folds of a hortus siccus, vegetated as soon as they were sown. I have seen a head of maize or Indian corn, taken from the grave of one of the Incas of Peru, and certainly buried more than three centuries, perfectly capable of germinating. Two seeds detached from it, and steeped in a solution of chlorine, *budded,* but from being neglected, and suffered to remain too long in the solution, the seeds did not make much progress after they were sown. This head of Indian corn was taken from an ancient Peruvian grave in Arica, on the west coast of South America: maize thus discovered has also been found to vegetate, in other cases. In 1830, Mr. Houlton presented to the medico-botanical society, a bulbous root taken from the withered hand of an Egyptian mummy: this root germinated in the atmosphere, and when committed to the earth grew freely. We have been informed that this root was an onion. Now, in all probability, this bulb had been shut up in the mummy case more than two thousand years—yet, from these sycamore coffins being completely air tight, its vitality was suspended, and as soon as it was placed under circumstances favorable to germination, its vital principle roused from its lethargy, was summoned into the exercise of its functions. On turning up the long neglected and desolate soil in the vicinity of the scites of monastic ruins, long lost varieties of the avena and triticum have been recovered, that may have reposed there for many centuries. Mr. Sinclair, of the Isle of Man, informed me that he had taken a portion from the centre of a solid mass of peat earth, at a depth of sixteen feet, in a bog, and having crumbled it, obtained from it a crop of ragweed when sown in a garden pot, and excluded from all extraneons sources. To the same effect precisely is an experiment made by Sir Thomas Dick Lauder: a quantity of mould was taken fresh from a soil, ovcrwhelmed not less than sixty years before, with drift sand: the mould was put into a shallow perforated earthenware flat, and covered with a bell glass, tilted, occassionally, to admit air: this was done on the 17th of February, 1832: by the beginning of May following, forty-six plants of four different kinds made their appcarance, and among these kinds, were the scorpion grass, and the forget-me-not. Of the same kind are some curious facts brought forward by Mr. Jessie, in his "Gleanings in Natural History." Thus, when the royal park of Bushy was dug up, sometime ago, for ornamental culture, a great many new flowers sprung up, and this had not been disturbed since Cromwell's time, more than 150 years ago, when it was used as a garden. It is well known that in the operation of trenching the ground for crops, the newly turned up earth, from a considerable depth, presents the picture of an entirely novel vegetation, the types of which are somctimes not found around the spot, and were not there before. 'About twenty years since,' observed a farmer to me, 'I broke up a field which had been in grass for fifteen years, and sowed oats in it; while the oats were growing, I did not observe one "kedlock,"* but in the succeeding year, the entire surface of the field was covered with them. About twelve years since', he continued, 'I dug up some soil from my garden, to the depth of about three feet, and filled the vacant space with rubbish to form a walk. The substratum of the removed soil was scattered on the surface of a field, here "kedlocks" grew in abundance, and no where else.' He further added, 'I am quite sure none of this subsoil had been exposed on the surface for at least a century previous, and perhaps not within the date of any record. A few years since I observed in a drain, that had been opened in a field, six feet deep, a crop of "kedlocks," about a year after it had been opened.' We shall, indeed, often observe on the mounds raised from the rubbish of the mine, coalpit, or quarry, vegetation altogether different from that which clothes the country around. In reference to this curious, and in our estimation, very interesting question, I may quote an extract from a letter to me from Mr. J. F. M. Dovaston, whose name I have had occasion to mention before. "We spoke of seeds lying dormant in the depths of the earth, till brought into vegetating distance, which, like the striking distance of electricity, depends upon circumstances, latent or colateral. About twenty years ago an attempt was made to find coal in Baby's wood, (properly Babin or Bavin, *gorse,* Welsh) near Whittington. From mere curiosity I went to see them. They were then about sixty feet deep, and as from time to time, I saw the gouge come up, laden with earth, I from a sudden thought, received part of the contents of this gouge into my botany box, which, on coming home, I emptied into a flower pot, I had previously subjected to the ordeal of a red heat. This earth I moderately watered with condensed steam, cold; and ultimately, thoroughly satisfied that no extraneous seed could have got near it, I obtained three plants; common white clover, trefolium repens, buttercup or crowfoot, ranunculus acris, and a species of grass, perhaps an agrostis; but it did not flower. About the same time, when they first sank for coal at Chirk, a few miles beyond, I observed great quantities of the weld or dyer's weed, reseda luteola, covering all the stuff that was thrown out of the pits from a great depth, and it has since crept with its undulated leaves and spiky crests along the roads, where it never appeared till the sinking of the coal-pits, as the botany of that delightful and romantic border of Wales was well known to me, and surely with regard to so common a plant." The Rev. G. Young of Whitby, informed me that some hazel nuts were discovered at a considerable depth in a morass, in the county of Durham, which grew when sown. These facts, which might be greatly multiplied, seem to prove to demonstration, that the earth brought up from a considerable depth, is impregnated with the seeds of vegetation, which have remained there for ages shut up, as in a dormitory.

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* Catlock, or Charlock, Sinapis arvensis.

The vitality of the seed is suspended in its exercise, and remains in a state of torpidity, until placed under circumstances favourable to its germination. In many instances, these seeds may have survived the universal wreck of the general deluge, and such seeds seem to us therefore, antidiluvians,—diluvii testis. These seeds, sown under common circumstances, give us complete types and counterparts of plants indigenous to our own country. An inundation, more local, may sweep into the ocean, the vegetation that clothes the surface of the ground, or the debacle tear up and destroy the alpine plants that mantle the rocks; but that very torrent may reveal new tribes of kindred plants, when its channel is dry; so curious and yet so wise is the Providence that wills 'that not one of these shall perish.' If we take the question as referring to a general cataclysm, the circumfusion of the diluvial waters, it affords an extraordinary proof, that the vegetation of a distant era, even when we go back before the deluge, was the same as now, for it has stamped its likeness on its seeds, and though many centuries have rolled away, the legend of their patriarchal history may be read in them. They are just such plants as we find indigenous to our island, and familiar to us. It follows, therefore, that the axis of rotation of the globe has not been changed from what it was in the antidiluvian period of the world; while the gigantic remains of tropical vegetation, which the geologist discovers impressed on the rock, or imbedded in it, as conclusively attest the universality of that tide which rolled over the globe.

When ashes are sprinkled over a heath, a crop of white clover is said to be produced. This, with other similar phenomena, are sometimes most unwarrantably and unphilosophically brought forward as a proof of the spontaneous origin of vegetation. These are atheistical speculations: we think it honest to call things by their right names. Such absurdities are the bane of true philosophy, and the worm at the root of the gourd: we therefore deal candidly with the question, and meet it fully and fairly. The old axiom, 'omne ex ovo,' though thus rudely assailed by this puny and pitiful folly, still remains as impregnable as Mont Blanc against the snow storm. The alkaline matter of the ashes may be well supposed to aid the germination of these seeds latent in the soil—thus olive berries do not germinate when sown; but, as it was observed, they did so after being swallowed by turkies; it was inferred that the alkaline matter of the system occasioned their germination. Accordingly, the olive berries were steeped in an alkaline solution, and they then grew. Mr. Macintosh, of Glasgow, applied kelp to particular drills of potatoes, while others were left without: a severe frost injured and blackened all the drills to which the kelp was not applied, but the others supplied with it, were not in the least affected, though the drills were contiguous; this is a very curious fact, and proves that ashes may act in a way we little suspect. Thus we know morels spring up plentifully, where wood has been burned; and we have already adverted to the practice adopted by the natives of New Zealand respecting the seed of the phormium tenax. The date tree, when injured, is cut down, burnt on the spot, and its ashes covered with a layer of earth. In such circumstances a new shoot arises from the centre. Hence, perhaps, the fabled phœnix represented as rising from its ashes; *phœnix dactylifera* being the botanical name for the date palm. To these facts, were it necessary, we might add others; all proving the extreme absurdity of drawing unsupported inferences from white clover springing up where none had been observed for some time before, on the surface of the soil being covered with ashes, the action of which is thus so easily explained. There is no warrant for such atheistical notions; all things continue until now, the same, we have every reason to believe, as they arose under the omnipotent fiat, during the hæxaëmeron of creation. Their perpetuity is preserved, and the impress of the originals, handed down from age to age. It will be therefore seen how reckless and gratuitous is the inference of some pseudo-philosophers, and how unwarranted the supposition of St. Hillaire is, when, in reference to the spontaneous production of vegetables, he concludes that soils contain silica, magnesia, carbonate of lime, &c., superadded to which is a "vegeto-animal substance;" and according to the absurd notion of Bory de St. Vincent, this nondescript may form either animals or plants—when it is to form plants it is called "matter in a vegetative state;" and when to form animals, "matter in a living state." This is indeed an odd process of convertibility, not very comprehensible. We should not have condescended to notice such trash, had not some of our British philosophers followed in their wake; we verily believe that they know not what they do; but are persuaded were they in sober reason to consider dispassionately the end to which these speculations lead, they would be startled at their temerity. Let not the march of intellect and truth halt in their enterprise,—I would tremble for such an inhibition,—but let reason supplant the whims of speculation; and calm and practical investigation take precedence of fanciful dogmas having no foundation in truth.

Some seeds are very tenaceous of life; they may be made to run the gauntlet of every vicissitude of clime, and alternation of temperature; others, on the contrary, are sufficiently susceptible of changes of temperature and moisture. Some seeds spring up in a few hours; while others require the lapse of years for their evolution.

Seeds will not grow if oxygene, or the medium containing it, be excluded; cress, mustard, and other seeds, did not swell in ether, sulphuret of carbon, and other media of a similar description, into which I had introduced them. Moisture, in the first instance, seems merely to soften the membranes of the seed, and dissolve the mucilaginous or albuminous matter, which is sometimes found to seal up the orifices that are the mouths of absorbent vessels. I find when seeds remain for a short period in distilled water, it becomes opake, and yields to the requisite tests, sufficient evidence of the presence of albumen, being coagulated by alcohol and acids. Carbonic acid gas distils copiously from the hilum or scar; the black patch, as seen on the bean. I placed a bean in distilled water, heated to 100° F., at the period when the testa or skin was rent by the advancing plumula; carbonic acid gas issued in a continued streamlet for a considerable period, and emanated chiefly from the scar, which, under such circumstances, may be perceived to be constantly studded with silver air bells, in parallel lines. Seeds generally will not grow under water, which may be ascribed to the denudation of oxygene, and saturation with carbonic acid gas. Atmospheric air, admirably adapted, as it is, for the respiration of animals, seems to be equally wisely apportioned to the requirements of vegetation; and though it be true, that plants will grow in other gases, and I have maintained the growth of cress in atmospheres of carbonic acid gas, hydrogene, &c.; still it is equally certain, that a healthy and luxuriant vegetation is alone found in the medium, which is designed for both. A certain degree of temperature seems to be, in ordinary cases, necessary; and perhaps from 40° to 80° F. may be the favorable range. Moisture, therefore, and heat, seem to be efficient agents in promoting the growth of vegetation; but we must not exclude electricity, as efficient in a much more important relation, than a mere auxiliary. The solar rays are indubitably proved to possess an electrical character; and seeds which are electrified grow much more rapidly than those which are not; though all the other circumstances besides, remain the same. Decandole, of Geneva, found that a vine grew an inch and a quarter in an hour and a half during a storm. Plants bristled with strong thorns, which act as attracting points for atmospherical electricity, are observed to have a rapid growth; and vegetation is always much more rapid, during a high electric condition of the atmosphere. Solutions of chlorine and iodine, as well as oxalic acid, appear to possess the power of exciting or stimulating the dormant vital principle, and thus seeds have been found to grow, that had resisted all the ordinary means employed for their germination, even after being preserved for more than half a century.

It is difficult to assign a limit to the extremes of temperature which may be resisted by some seeds and plants: remarkable examples will be found in another chapter. Even animal life may be supported at temperatures which are almost incredible to the ordinary observer. The larvæ of the musca chameleon sport in the thermal waters of Loeche, in the Canton of the Vallais: and animalculæ are sometimes found alive on the milt of a boiled carp. In vegetable nature, there are parallel phenomena: trees have been watered at the roots with boiling water, without the slightest injury: the vitex agnus castus grows very well with its roots immersed in water at 170° F. I found that peas and beans cast into boiling water, and suffered to cool, still grew: several cress and mustard seeds, which were projected on a hot iron, grew; and even germinated in other cases, when momentarily boiled, or put into boiling water and allowed to cool. A late near relative of mine brought from the West Indies a quantity of ginger, the roots of the amomum zingiber; and it should be observed that, after the roots are taken from the earth, they are steeped in boiling water to destroy their vitality: notwithstanding this, these roots sprung on the homeward voyage; and such was the power of vegetation that it forced open the lid of the box, though fastened down with nails. Even mushrooms have, by their growth, raised the flag stones of the pavement. When one of the hothouses, in the 'Jardin des Plantes,' was burnt down, a plant of the phormium tenax survived the conflagration that consumed its leaves to charcoal.

There is a phenomenon of some interest connected with seeds, which I shall just notice. When we consider the circumstances under which aphides are found, and other insects, which seem to make particular plants their natural habitats, such as aphis rosæ, a. fabæ, a. urticæ, and others, we are perplexed to think where they came from, or where has been their dwelling-place. The eggs of aphides are not found any where: they have not been seen by the keen eye of the most prying naturalist: in due time, however, they make their appearance, and that often suddenly. I am of opinion that the ova of some minute insects may be absorbed by the seed along with the pollen, and grow with the growth of these seeds. In other cases they may enter into the vegetable system by the roots, and finally find their way out by the bark. I am ready to grant that this view is novel, and may not be received unquestioned, but as I am no dealer in rash hypotheses, and unsupported speculations, I consider that experiment and observation both warrant my conclusions. If the seeds of hyocíamus, or henbane, be projected on hot iron, and the vapour received and condensed in a glass placed over it, minute larvæ will be seen on the interior surface. This I have found to be the case also with some other seeds; now the vital principle of these seeds may still remain unaffected. The larvæ, into which the ichneumon buries its eggs, continue frequently to live, move and eat, when they are one living mass of parasites. It is scarcely possible to conceive otherwise, of the parasitic attacks of corn and barley, but on the supposition of the absorption of their seeds by the roots. I advert to the rust and soot puff, or the pepper and dust brand, uredo fætida and uredo segetum. With such an admission, the solution seems at once natural and easy; and it will solve a variety of phenomena of a similar kind, which, without such a supposition it seems difficult, nay almost impossible to do. The experiments, indeed, of Fee appear to be altogether conclusive on the subject—that the seeds of fungi are really absorbed by the roots of plants.

The growth of plants presents diversified phenomena: sometimes it is slow, and almost becomes stationary after a short period; even after the lapse of centuries, it still remains stunted in stature. Two cases of rapid vegetation have been already stated. The bamboo rushes up to a height of 80 feet in one season. The Ayrshire rose has made a shoot of 60 feet in one year. The hop, and many other climbing plants, shoot to an immense length during their annual growth. A former king of France has been reported to have known a secret process, by which he could rear sallad, while a joint of mutton was being roasted, and that he esteemed the secret rarely: chicory was stated to be the seed. We may reasonably, however, be allowed to remain sceptical on this point. I am informed by an intelligent individual, sometime resident in the West Indies, that in thirteen or fourteen months, after the seeds of bananas are planted, they will have sprung up fourteen feet high, having a stem ten inches diameter. Within twelve months after the seed has been sown, they will have ripened their fruit, and formed a dense grove. In tropical countries, indeed, vegetation progresses with extraordinary rapidity. In Asia, it is said, some land will bear three crops a year. Vegetation is so rapid, that as fast as the water rises, the rice grows above it, so that the ear is never below the surface: the vine bears fruit in the first year. Indeed, in Naples, I was informed that three crops were often reaped; first,—wheat, cut down in June; this was followed by melica quarantina, a kind of maize, of extremely rapid growth; and when this corn was reaped it was followed by lentils, &c. The calampelus scaber, or lithosphermum scandens, a native of Mexico, affords an example of quick vegetation. A plant in April, 1832, one foot high, at the close of the year, was sixteen feet in height, and measured forty-four feet in circumference. Even the growth of the oscillatoriæ is remarkably rapid. According to Carmichael, if a small portion be taken, not exceeding a hair's breadth, and placed in a watch glass containing water, it will, in the course of a night overspread the surface of the glass.

It will not be out of place to recur to modern speculations respecting life and motion; and we lament to say that Mr. Robert Brown, an eminent practical botanist, has given countenance, and lent his name to the perpetuity of the most wild and visionary fancies, that ever were promulgated. The French naturalists were sufficiently eccentric without any such addition to their impetus. I ought to observe, however, that Needham, in 1745, had already observed the movement of particles of pollen. The pollen of the mallow, after immersion in water, ejects its contents; and pollen has, after a repose of fifty years, burst its cells, and shed its subtile powder; but, according to Mr. Bakewell, the phenomenon ceases, when the sacs are emptied. Even the Continental philosophers admit that these granules have an immobility, and a perceptible motion, under circumstances entirely similar. Ellis said, "minute seeds which evolve under water from fungi, and mosses, and appear to have a spontaneous motion, derive that motion from minute animalculæ in the water, which, by pecking at the seeds, move them about in every direction, while the little animals were scarcely visible till the food they had eaten discovered them." This is a very rational solution, and accords with observation. Hancock observes, if walnut oil be poured on alcohol, the globules of oil will be put in motion, and revolve on their axis, like the planetary orbs. In like manner, small fragments of camphor projected on water sometimes spin on their axis. No one believes, however, that these possess any thing like life. There is a singular phenomenon exhibited by casting the leaves of schymus molle on water; they discharge an oleaginous fluid, and the leaf recedes, by jerks, from the reaction of the water. Under such circumstances, the leaf of the schymus molle has a distant resemblance to that curious aquatic insect, called the notonecta. The action of moisture, already referred to, as presenting phenomena somewhat similar, solve the problem of these movements very satisfactorily. Mr. John Bywater, of Liverpool, who preceded Mr. Brown, had discovered, as he supposed, moving animalcules in coal ashes, powdered marble, with other etceteras, and these remarkable appearances were, with all due formality, registered in his "physiological fragments," a copy of which he had sent me* before ever Mr. Brown pursued and extended the subject. Perhaps the whole affair would have passed off very quietly, had not Mr. Brown resumed the subject, and by the authority of a name given it currency. According to Mr. Brown, as soon as any thing is reduced to powder, and cast into water, it is forthwith *alive.* It may here be asked why not *before* being thrown into water? The table, chairs, rocks, every thing around us, or connected with us, when reduced to powder, and cast into water becomes alive. A fragment of window glass, pulverised, gum, resins, pit coal, metals, volcanic ashes, aërolites, granite itself, even a portion of the sphinx in the British museum—all became alive. It is a fortunate circumstance that the sphinx has not yet walked off, for, composed as it must be, of myriads of liliputian mobile particles, 'yclept ' active molecules,' the power of numbers might be reasonably supposed to effect its escape. According to Mr. Brown the whole of London dust is alive! or composed of " *active molecules.*" Mr. Brown says "a discovery like this is not likely to be received without considerable scepticism; and hence we find one portion of the world believing by the exercise of faith; and another, by far the largest portion, doubting the existence of the facts because their theories anticipate the laws of nature, and they have not patience to wait for further information." Then follow some remarks about " illusion," and " lively imagination." We pass over the sneer about " faith,"—as not appertaining to physical science,—*valeat quantum.* His conclusions amount precisely to this:—The ultimate particles, obtained from all bodies, whether organic or inorganic, have an inherent motion like vital action; nay, though he has subsequently affixed a salvo against this inference, his original paper plainly left us no alternative but the deduction that these ' ultimate particles,' as they are called, or "molecules," agreeable to the French version, were *alive.* If Mr. Brown be correct, then it follows, as a matter of course, that we have only to cast dust into the water, and straightway it becomes a tide of animation. We have merely to reduce the mountain to powder, and toss this powder into the ocean; and we infuse into it a mass of living " molecules," so that as our rocks wear away, they melt into life; and why may not the sands on the sea shore, when wet by the returning tide, come trooping into the adjoining town or hamlet? This is, if what our author says be true, a very possible case. Can any person, in his sober senses, believe such nonsense: it amounts to this—*separation* of parts gives individual life to each particle; but in mass, all is still and dead. Remove every cause of vibration, and boil the water previously, to destroy animalcular life, precautions adopted by Mr. Bakewell, and it will be found, as he proved it to be, and what was naturally to be expected, that these movements cease. Withdraw the sunbeam, and its calorific and electric powers, and you may call 'from morning to night' on these 'active molecules,' and bid them dance, but they will be still and motionless. If these 'ultimate molecules' have innate motion, we must give up our former philosophy, and commence a new series: for what, under such circumstances, becomes of the vis inertia of matter? All our mechanical science tumbles to the ground.

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* I mention this to prove that the merit of priority, in discovery, *such as it is*, belongs to Mr. Bywater.

> ——— " Has matter motion?—
> Then, each atom, asserting its indisputable right to dance,
> Would form an universe of dust!"—

The whole stability and permanence of material things depend on principles, the very reverse of those assumed by Mr. Brown. We may now advert to the opinions of other observers, respecting the motion of pollen. M. Raspail says " I have never discovered the smallest trace of it;" and Dr. Brewster's observation is to the same effect, "I have never perceived, in grains of pollen, a single motion in the least degree characteristic of animal life." We may here observe that if equal parts of 'compound spirits of lavender,' coloured by red saunders wood, and a saturated solution of muriate of soda, be mixed together, the mixture will precipitate all the colouring matter. When this is placed in the sunshine, the red particles will be instantly put in motion: they will ascend to the top in sunshine, and fall again in the shade.

It was easy to anticipate where these reveries would end. Bory de St. Vincent, imagined he saw matter, for the first time, assume the aspect of a simple mucosity, without colour or *form*. This finally became a pelicle at top, was thereafter turbid, and disclosed an infinity of living atoms, or monads; which, after being magnified a thousand times, were not the size of the point of a needle, yet moved in all directions with great velocity. Matter, according to our author, assumes a living state, when the water is exposed to air and light; then the green matter of Priestley is rapidly formed; a kind of conferva, according to the opinion of some. St. Vincent thinks, that this is a combination of a more general form, and only susceptible of entering into the composition of these plants, as well as the animalculæ, which issue from them, and produce them. He duly names this matter in a vegetative state; and by this, the infusory animalculæ are coloured green. This I confess is to me not very intelligible, if indeed it be at all comprehensible. Dutrochet, however, has shewn that the green matter in stagnant waters, and assumed microscopical animalculæ, are nothing more than gelatinous matter influenced by electrical currents: simply, the germination of the more common mosses imperfectly developed, for want of requisite media and support; notwithstanding all this; Professor Delpech, and Dr. Coste, received the large gold medal of the "societe des sciences physicales," for "the formation of embryos by the action of electric currents!" Then, as a matter of course, we read of 'spontaneous generation,' 'march of nature,' 'propagules animées,' 'vis formatrix,' 'l'espéce des foyers,' and all the rest of the incomprehensible jargon of the French school; with similar sounds harped on the same string, such as 'the tendency of bodies to become animated,' 'a provisional creation waiting to be organized;' and as a sequel, the mutual convertibility of plants into animals, and animals into plants. Now, if these puerile absurdities are not *Atheistical,* I confess myself unable to comprehend the meaning of the simplest language: and I pity the individual, who can be hoodwinked with such trash. Some, there are, who have alluded to these buffooneries with a courtesy and deference which they do not deserve; but truth requires that such rash assumptions should be held up to the finger of indignant scorn. We believe Priestley and Ingenhouz were the first to take particular notice of the green matter deposited in water, remaining stagant for sometime, and may be seen occasionally in the water-bottle, where the water is not often changed.

Sir George Gibbes, of Bath, about three years ago, printed a pamphlet, not published, being intended for private circulation; a copy of which however he favoured me with. In this pamphlet there are views and inferences not very dissimilar as to the green matter, or *matière verte* of Ingenhouz, to those developed by Bory de St. Vincent. Sir George seems to think that this matière verte, when it is decomposed, resolves itself into living monads, these again coalesce, as so many links of a chain, and under certain circumstances become re-metamorphosed into the matière verte. We think Sir George Gibbes altogether mistaken. This transmutation seems, when properly considered, to be altogether gratuitous; and to this effect I personally expressed myself to this eminent individual, assigning my reason for dissenting from the opinion. Prima facie, it is hard to be believed that a beautiful form should arise from the turbid pelicle of St. Vincent, or, in other words, order from confusion and chaos, through the medium of a 'provisional creation.' May not this slime be the veil where the ova of animalculæ are deposited, or animalculæ are hidden? and as to the mutual convertibility of these microcosms into plants, and vice versa, it seems never for a moment to have been imagined that there may be a melange of the ova of animalculæ, and the microscopic seeds of byssi and confervæ; or, the former may be interlaced with the minute cellular filaments of these diminutive plants, or enclosed in their cells. Besides, electricity accelerates the evolution of the chick from the egg, and the germination of seeds, and its agency in the same way over the animalcular ova and cryptagamous sporules is a reasonable deduction. All these circumstances should be well weighed, and the facts of the case correctly ascertained, before our reason is doomed to shudder, by the shock of atheism. The fact is, the 'matière verte' is only an imperfect development of one of the mosses, having the same relation to the perfect plant nearly, as the larvæ to the insect imago. Numerous mistakes have doubtless been made in this way: thus the byssus velutina is only the incipient stage of the polytrichum alöides. But all these airy speculations have been dissipated by the very interesting researches of Professor Ehrenberg, who has discovered in animalculæ, even in those we have been accustomed to regard as the very type of simplicity, such as the monas termo, and atomus, a most *complicated structure,* and by an ingenious method of infusing colouring matter into these microscopic forms, he has ascertained the existence of numerous stomachs: in the monas termo, there are four! these discoveries are important for the cause of truth and science; however destructive they be to these visionary dreams. Let us also consider the difficulty of excluding the ova of animalculæ, and the sporules of cryptagamous vegetation, from water, when we make our deductions. We have already adverted, in the case of the boiled carp, to the high temperature which animalcular life may sustain, and for aught we know the sporules of acotyledonous vegetation, called cellulares, in the cryptogamia of Linneus, may, in many cases, pass unscathed through even a more severe ordeal; a conclusion in which we are warranted, when we consider the high temperatures under which the ulva thermalis is sometimes found.

These remarks shew the importance and necessity of being acquainted with vegetation and zoology, on a most comprehensive scale, and their myriads of diversified relations, before hazarding such preposterous notions as these, which seem to be rather the creations of insanity than the deductions of reason. We may now quote the apposite remarks on this subject by the writer to whom I have had already occasion to refer. "If it be possible to change a plant into the humblest animal, even into a water hydra, which may certainly be propagated by cuttings like a plant,—then the conversion of an oak into an elephant, or of a bundle of thistles into a donkey, is brought within the pale of possible expectation." As to the "slime," consisting of algæ in their simplest state of organization," being a "provisional creation waiting to be organized."—"Here," continues this acute author, "the very same substance is first 'algæ in their simplest form of organization,' then it is 'a provisional creation waiting to be organized,' and at last it is to assume different forms, 'according to the nature of the corpuscles which penetrate it or develope among it.' Now, if it be young algæ, even in the simplest state of organization in which they can be visible or exist, it cannot, at the same time, be 'waiting to be organized;' and if it be waiting for the corpuscles, (what are they?) which penetrate it, or develope amongst it, it cannot be algæ but as to serve for the *locus*, or the *pabulum* of those foreign corpuscles. If it is merely meant to be said that the *germs* or *sporules*, or whatever they may be called of the algæ are jelly-like, we believe that the same may be said of the very earliest organization of all vegetables and their seeds, and thus we are where we began."*

Many opinions and theories have been expended on the question of the ascent and circulation of the sap. Some have supposed one thing and some another, and hypotheses and theories have, one after another, been supported and successively abandoned; nor, up to this moment, is there any satisfactory solution of the phenomena. Passing over various hypotheses framed to account for the ascent and descent of the sap, such as capillary attraction, and the expansion and contraction of the vessels by means of heat and cold, we may state that Mr. Knight's theory ascribes the phenomenon to the action of the *silver grain*, or the thin shining plates, observable especially in oak wood. These, which seem to be very susceptible of changes in heat and moisture, by pressing on the sap vessels, operate in the circulation of the sap; 'their restless temper,' says this author, 'after the tree has ceased to live, inclines me to believe that they are not made to be idle whilst it continues alive.' The main difficulty is to ascertain correctly, the vessels or channels through which the sap is propelled. Some have supposed the fibres of the wood to be the vessels in question; and among them we find the names of those eminent phytologists, Duhamel, Malpighi, and Grew; Darwin was more of a poet, than a sound philosopher. In the spiral vessels, already considered, air, and sometimes moisture has been discovered. Twigs of the figtree, apple, and horse chesnut, placed in decoctions of madder skins, of the black grape, and logwood, absorbed liquid colouring water, which was traced by Mr. Knight to the leaves, but neither the medulla nor bark were at all tinged. These spiral vessels, called *central* vessels by Mr. Knight, from their position, are supposed by him to be the channels of the sap, and connected with its flux and reflux. Some have supposed that the sap rises and flows through the interstices among the cells. Link of Berlin, states that the vessels among the cells are found coloured, from the infusions employed, and not the individual cells, which remain colourless. Decandole's opinion is something of this kind. Dutrochet's theory may be concisely stated, though it is almost superfluous, seeing he has since abandoned these views. According to the opinion of Dutrochet, the soluble matters absorbed by the roots, are carried to the leaves, in spring, through the false tracheæ of Mirbel, or lymphatic tubes of Decandole, found in the soft and hard wood. The sap being finally elaborated in the leaves, descends through the inner bark.

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* The other day I observed a curious phenomenon of motion in seeds. Having shaken the seed from the frond of a dorsiferous fern into the palm of my hand, I found that in a few minutes, the warmth communicated a singular motion to these seeds, they leaped about as if they were animated, and resembled the leaps of the flea, or some of the claters.

Hence the radiated tracheæ of the wood give off and disperse *laterlly* a portion of the ascending sap, which forms the *alburnum;* and those of the bark, the descending or elaborated juice, after it has undergone a change in the leaves, dispensed also *laterally,* to form the liber or inner bark. The former, therefore, it will be perceived, adds an annual layer of alburnum, and the latter, a new layer of *liber* or inner bark.—Negative electricity, according to Dutrochet, imparts the power of absorption, and positive electricity, the power of secretion. These powers Dutrochet calls *endosmose* or inflowing, and *exosmose* or outflowing. Porrett had, by electrifying two fluids of different densities, separated by a thin diaphragm, found that they exchanged places, and passed through the membranous partition. Dutrochet discovered that if a portion of the cæcum, or blind gut of a chicken, be filled with milk, and a tube be attached to the upper orifice, the liquid rises in the tube, when the cæcum is immersed in water, and finally overflows. This is effected by a lateral absorption of the water; and will illustrate what is called endosmose. In process of time, the milk undergoes decomposition, and the liquid falls in the tube, from the expulsion of the water through the lateral orifices of the cæcum, by which it had previously entered; this last is an example of exosmose. These experiments have been ingeniously modified, and many curious results arisen from their extension and modification. It is, for instance, found, that when a bladder, containing a small quantity of carburetted hydrogene is introduced into carbonic acid gas, the bladder becomes distended, and finally bursts, from changing its contents: and those who are in the habit of making experiments with gases enclosed in bladders, know how soon these gases are deteriorated. Thus water will pass through a membrane which retains alcohol. The experiments of Dalton are equally curious. If seventy-nine parts of nitrogene be introduced into a vessel, and twenty-one parts of oxygene into another vessel, and a communication be made between them; it will be found that the mixture is, in process of time, most intimate; though the oxygene be made to occupy the lower, and the nitrogene the superior vessel; the former mounting upwards, contrary to the laws of gravity, and the latter descending. I have also found this to be the case in a variety of other instances, where the difference of specific gravity was yet more considerable. The phenomena presented in these cases are facts extremely interesting, but by no means so easy of solution. We cannot doubt however, that they are parallel with what takes place in the leaf, and the maturation of fruits, and so far are worthy of due attention; though they may fail in the case, to which Dutrochet had originally supposed they would apply. A very curious circumstance of this kind is mentioned by Dr. Walsh. A fruit-bearing branch of the phœnix dactylifera, or date palm, was sent to him from Damietta in Egypt; the fruit was not ripe, but he was directed to cover the end of the branch with a piece of bladder, and hang the branch against the wall; he did so, and we are told that the fruit by this process gradually ripened of a large size, and good flavour.

The sap, the materials of which are received by the roots, ascends, by specific channels, through the alburnum, to the leaves, where, being exposed to the action of light, it becomes *cambium,* or "proper juice," and finally descends through the vessels of the bark; being deposited between the liber and the alburnum. It appears to me evident that the sap, in its ascent to the leaves, and before it is elaborated in them, ministers neither to the deposition of new wood or new bark, and that both these are effected, subsequently, in the descent of the cambium. The phenomena of the liquid contents of the ascidia of the nepenthes, seem to me, to throw a flood of new and remarkable light on the entire question of the circulation of the sap. I consider the liquid matter as the sap which has ascended from the roots through the stem; the chemical analysis of which I have also given. That this sap does undergo a change in the pitcher, is sufficiently proved by Dr. Graham, the present professor of botany in the Edinburgh university, for he states that the liquid in the pitchers in an early stage, is distinctly "subacid," and increases in acidity to the final period of maturity. We have already mentioned, that when the season for perfecting the periodic growth of the plant is over, the ascidia seem of no further service; the lids open, the contents are poured out, and the pitchers wither away; but there is this circumstance overlooked in the curious physiology of the nepenthes. There are comparatively *few* pitchers on the plant; every leaf is by no means supplied with one; on the contrary, a limited number, by no means corresponding with that of the leaves, seems sufficient to complete the purposes of its physiology. I have already described the numerous orifices which open into the pitcher,* and the immense multitude of spiral filaments connected with them. I have also mentioned that my own observations corroborate those of Rumphius, that the pitcher is replenished during the night. I consider that the sap of the pitcher, after having been elaborated by the electro-chemical action of light, is absorbed by these spiral vessels, and by them descends. So long, therefore, as the sap is ascending, these pitchers are necessary, and are in fact, so many chemical vessels, where changes more curious are going on, than we can repeat in our laboratories. When the sap, toward the close of the year, ceases to flow upwards, the pitchers are no longer of any use and decay, while others supply their place in the following season. By the experiments of Duhamel, and Dr. Hope, the alburnum, or new wood, appears to be secreted from the interior surface of the liber, or inner bark. The former introduced plates of tinfoil under the bark of trees, and found layers of new wood on the outside of the tinfoil; the latter made a very interesting experiment on the branch of a willow which proved the same thing, still more unequivocally. The bark was carefully separated in the form of a hollow cylinder, from the wood, the ends being untouched, the lips of the bark were united, and the branch then bound up, to secure it from external injury. After a few years, the branch was cut through transversely, and the cylinder of bark was found lined with layers of new wood, corresponding with the cylindrical rings above and below the part which was the subject of experiment. There are two classes of growth in trees: one of these is called *endogenous,* or inward growth, and the other *exogenous,* or outward growth. The first class do not increase their diameter, while the latter do. The palm is an example of the former, and finds its semblance in the stem of the lily; the trees of our forests illustrate the latter of these modes of growth. The palm exhibits the same diameter, throughout the entire extent of the trunk; but the oak and the elm taper towards the top. A correspondent, in Mr. Loudon's 'Magazine of Natural History,' has propounded a new theory of the ascent of the sap, which is, I believe, as good as any of the rest. "The sap in its descent in the stem, becomes deprived of some of its constituents, more especially of its aqueous part: this deprivation is effected by the vital principle of the plant decomposing the aqueous parts, and assimilating the resulting gases to its own constituents. As the assimilation takes place, a partial vacuum is formed by the change of gas to a solid form; and this vacuum is immediately filled with sap rushing into it, according to the well known law of the tendency of fluids to rush into any cavity, deprived of the presence of air." We shall not comment on this ingenious theory, which might be assailed by numerous objections. The province of secreting new wood as well as new bark, belongs entirely to the descending sap; and until it has become "proper juice," or cambium, in these vegetable laboratories,—the leaves; the sap is null to all intents and purposes; and is to be regarded as merely composed of the unchanged products derived from the soil; so that the vessels, through which it mounts upwards, are mere hydraulic conduits, for we conceive no chemical change takes place in the sap after it passes the spongioles, until it arrives at the leaves; where, however, a remarkable change supervenes. Some of the secreted materials are appropriated and assimilated, and others evolved by peculiar glands, apparently designed to throw off what is superfluous. The chemical analysis of the sap, before it reaches the leaves, shews it to be simple, and to vary but little. In the sap of the elm, Vauquelin found water and volatile matter in great excess, acetate of potassa, with a little carbonate of lime, and vegetable matter; and in the beech water, the acetates of lime, potassa, and alumina; with gallic acid, tannin, and extractive matter. In the sap of the hornbeam, he found acetates of lime, potassa, and alumina, sugar, and extractive matter. The sap of the vine, according to Dr. Prout, did not differ in specific gravity from pure water, nor did it sensibly redden litmus paper. According to the experiments of Mr. A. T. Thomson, the specimen he examined, contained acetate of potassa, carbonate of lime, mucilaginous and albuminous matter. In these analysis, however, it must be remembered, that the sap varies at different periods of the year, in the same tree; and it is almost impossible to obtain the sap pure and unmixed with cambium, or "proper juice." There seems to be one great circulation, which has an annual period, this we have already adverted to; and a fact may now be mentioned that seems to prove that the autumn is the period when permanent secretions are more distinctly stamped on the tree. If a variegated laburnum be budded or grafted on a common laburnum, the foliage above will be variegated; should it be decapitated below the bud or graft in the *second* year, the foliage beneath will still be variegated; if, on the contrary, it be done before the close of the first year, and the descent of the sap, it will not. But while I presume there is what may be called a more general or universal circulation, I cannot but think, that in some cases at least, there are partial or local systems of circulation in plants. The chara genus, from their translucent stems, afford great facilities for viewing these curious phenomena. M. Blainville, as well as Amici of Modena, have distinctly seen the circulation of the sap in the chara vulgaris. The microscope magnified 1500 times, and exhibited the motion of two liquid currents, the one ascending and the other descending, circulating in the same tube without the insulation of a diaphragm. This seems to have been put beyond a doubt, by the distinct passage of certain particles of one of the currents; which, being attracted by those moving in the opposite direction, were occasionally dragged along with them. The tube in which this double circulation took place, had a very sensible diameter. This very curious phenomenon has been witnessed by many in this country; the joint of a chara is employed for the purpose, and the sap, under the appearance of a multitude of air bells, is distinctly seen to ascend on one side, and descend on the other: this exhibits the phenomenon of two longitudinal bands with an intervening band, unoccupied by any palpable circulation. Mr. Burnett has concluded that each joint of the chara has an individual or peculiar and insulated circulation, being complete in itself; though it may communicate with other joints. It appears that the section of the joint shews it to consist of two lateral ducts, having a spiral direction, though not spiral in structure; these ducts have opposite directions, and are twisted round a central axis.

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* Perhaps one of the Penang species; at any rate, now in the Botanic Garden of Hull, where I obtained my specimen.

These are curious and interesting discoveries, and shew that every step of advance made in genuine science affords an additional attestation to the wisdom of the supreme CREATOR.

We must confess that, to us the ascent of the sap in spring is a problem of no great difficulty. The same agency that rouses the tortoise and the dormouse from their torpidity, awakens the dormant powers of vegetation, and the chief agency is certainly that of temperature. Thus awakened, the functions of the plant are summoned into exercise, and the sap received by the root mounts upwards to the top of the loftiest palm or pine. The mere action of heat therefore, and light with its electricity, will sufficiently account for the ascent of the sap in spring. In many instances this ascent is sufficiently rapid, as is seen in the balsam, when we neglect to supply it with water: a few minutes suffice for the effect of the water it receives, being seen, ramifying even to the extremities of its branches and leaves. The nyctanthes arbor-tristis, or sorrowful tree, of the East Indies, droops its branches and leaves during day, and seems about to fade; but the evening dews revive it, and it is fresh and verdant during night.. A very interesting experiment was made by placing two vines in tubs of water: one of these being introduced into the hothouse, through the wall, soon unfolded its foliage, and in the same ratio was the water absorbed; the other was tardy in its progress and proportionally slow in the absorption of the water. The same thing precisely is seen by training the top of a tree planted on the north side over the top of a wall, and admitting it thus to a southern exposure, the difference in the advance and maturity of leaves, flowers and fruit, will be soon sufficiently obvious. The power of the ascending sap is immense: in an experiment made by Dr. Hales, the sap of a bleeding vine rose in a tube to the altitude of forty-three feet, thus counteracting a pressure equal to a column of thirty-eight inches of mercury. Mr. Braddick attached a bladder to the orifice of the branch of a bleeding vine. In twenty-four hours it became as hard as a cricket-ball, and soon afterwards burst with a considerable explosion. The proper juice is of various colours and properties in various plants. It is caustic in celandine and euphorbia, resinous in the pine, mucilaginous in the cherry, sweet in the sugar cane, narcotic in the poppy, &c. It is red in logwood, and the bloody dock, rumex sanguineus, yellow in fustic, and white in the fig. In the red cabbage it changes to blue on the rupture of the vessels; and the late Mr. Smithson imagined that this change resulted from the escape of carbonic acid gas, which he assumed to be the cause of its red tint, before the vessels were torn, from the supposed circulation of this acid in the plant. But I find, experimentally, that by *heating* this blue fluid it becomes *red*, a circumstance which would tend to expel carbonic acid gas were it present, and produce a contrary effect: I also find that litmus paper, when heated, becomes red, and that its original colour is restored by alkalis. There is, in fact, some very singular phenomena connected with changes of colour, which are yet to be developed, and will afford many curious results under a patient and long continued investigation. No doubt the sap, as well as proper juice, will be modified by circumstances; the juice of sugar canes that are raised close to the sea coast absorb so much muriate of soda, as to render the sugar almost useless. It has been ascertained also in America, that when muriate of soda is applied to fruit trees; the fruit is so salt, as to be almost unfit for use; this is especially the case when salt is applied to the peach tree. No doubt the flavour of fruit may be materially altered by the constituents of the sap. That delicious nectar, the "tokay," is not the produce of Tokay, but its environs, Tarczal, cultivated at a distance from the town, and scattered along a mountainous ridge extending more than twenty miles. I am informed that the *stalk* of the grape is *twisted* to impart somewhat of a raisin flavour to it: this would modify the sap and cambium. Its taste is quite peculiar, intermediate in flavour, between that of new made hay and green tea. It appears there are three kinds of it; the finest quality goes by the name of essence. The yearly produce, on an average, amounts to 110,000 aulns.

Mr. Keith says, that the sap has the power of producing buds in a lime tree, and that two shoots were protruded from the lip of a wound. A piece of the shoot of a common elm, used as a perch for the 'rana arborea' (tree frog) shewed a similar tendency. By cutting through the bark to the wood of a fig tree, and removing a thin strip of bark, to prevent the contact of the lips, making the section in the form of an inverted V over buds, that shewed no tendency to produce branches, I obtained a shoot from every one of them. The quantity of sap which sometimes distils from a tree, when it is wounded is immense; two of the branches of the euphorbia antiquorum, when cut in sunder by Bruce, afforded more than four gallons of sap, (cambium,) it excoriated the skin as if boiling water had been applied, and permanently stained the blade of the sabre, that cut the branches: the products which are obtained from wounding the barks of trees are various, as caoutchouc, gum, resin, &c., and some of these have considerable officinal importance. Occasionally the liquid matter which exudes, is coloured: when the pergularia sanguinolenta is wounded in any part, there follows the discharge of a fluid of a turbid blood red colour; and Humboldt mentions that the purple juice of the dragon's blood tree, croton sanguifluum, was frequently seen flowing over the whitish bark. Trees when wounded, afford sap or juices which frequently yield an ardent spirit when fermented, such as arrack, or wine and sugar: thus palm wine is obtained by wounding the trunk of the palm. When the sap of the Chili palm, micrococcos, is boiled down to a syrup it is used as honey: the sap of the birch is obtained by wounding the bark of the tree at the season when the sap flows: this sap is sold in the market of Mansfield at about one shilling a gallon, and when judiciously fermented, and no spirit is added, at the age of two or three years, it might easily be mistaken for a foreign wine. Early in March the white birch, betula alba, is wounded, and the wound is kept open, by attaching a vessel to the orifice: from two to three gallons a day are readily obtained. In twenty-four hours, a twig of the vine has furnished from fourteen to sixteen ounces of sap. The maple tree yields two hundred pints in the season; and the birch a quantity which has been computed to be equal to the entire weight of the tree: when a tree is tapped, it is perforated sometimes to the centre of the tree, generally to the alburnum, and the seasons when the sap flows, are those of spring and autumn, particularly the former; nor does the tree seem to suffer from this extraordinary drainage. The sap of the sugar maple, acer saccharinum, affords sugar; it is chiefly cultivated for this purpose, in the Canadas, but we found that the manufacture had also been profitably carried on in Switzerland, as we believe it has been in some parts of Germany, particularly in Bohemia.

It has been stated by an American writer, that the sugar maple is about sixty feet high, and that from six to thirty gallons of sap is obtained from each tree; every six gallons of this sap yield one pound of sugar; or, according to Duhamel, every two hundred pounds of sap supply ten pounds of sugar: the specimen of maple sugar which I have seen, was rather dark, but completely crystaline. By far the most interesting production for its peculiar secretion is the 'cow-tree', a species of brosimum, which Mr. Don informs me, has not yet been figured; it is probable that the shea, or 'butter-tree', mentioned by Park, at Bambarra, belongs to the same class as the palo de vaca, or cow-tree, described by Humboldt, as growing on the shores of the Cordilleras, and found most plentifully between Barbula and the lake of Maracaybo "On the barren flank of a rock, says Humboldt, grows a tree with dry and leather-like leaves; its large woody roots can scarcely penetrate into the stony soil. For several months in the year not a single shower moistens its foliage. Its branches appear dead and dried; yet as soon as the trunk is pierced there flows from it a sweet and nourishing milk. It is at sun-rise that this vegetable fountain is most abundant. The natives are then to be seen hastening from all quarters, furnished with large bowls to receive the milk, which grows yellow and thickens at its surface. Some employ their bowls under the tree, while others carry home the juice for their children. This fine tree rises like the broad-leaved star-apple. Its oblong and pointed leaves, tough and alternate, are marked by lateral ribs: some of them are ten inches long. We did not see the flower. The fruit is somewhat fleshy, and contains a nut, sometimes two. The milk obtained by incisions made in the trunk is glutinous, tolerably thick, free from all acrimony, and of an agreeable and balmy smell. It was offered to us in the shell of the tutuno or calabash tree. We drank a considerable quantity of it in the evening before we went to bed, and very early in the morning, without experiencing the slightest injurious effect. The viscosity of this milk alone renders it somewhat disagreeable. The negroes and free labourers drink it, dipping into it their maize or cassava bread."

This accomplished and interesting traveller thus continues; "among the many curious phenomena which presented themselves to me in the course of my travels, I confess, there were few by which my imagination was so powerfully affected as the cow-tree. All that relates to milk and to the cereal plants inspires us with an interest, which is not merely that of the physical knowledge of things, but which connects itself with another order of ideas and feelings. We can hardly imagine how the human species could exist without farinaceous substances, and without the nutritious fluid which the breast of the mother contains, and is appropriated to the condition of the feeble infant. The amylaceous matter of the cereal plants,—the object of religious veneration among so many ancient and modern nations,—is distributed in the seeds, and deposited in the roots of vegetables; while the milk which we use as food appears exclusively the product of animal organization. Such are the impressions which we receive in early childhood, and such is the source of the astonishment with which we are seized on first seeing the cow-tree. Magnificent forests, majestic rivers, and lofty mountains clad in perennial snows, are not the objects which we here admire. A few drops of a vegetable fluid impresses us with an idea of the power and fecundity of nature."

Connected with a phenomenon so truly interesting, we subjoin a communication on the subject dated from Trinidad;—'I have just returned' says Mr. D. Lockhart in a communication to A. B. Lambert, Esq., "from an excursion to the Caraccas, where I collected the juice of a cow-tree (palo de vaca), and I have now the pleasure of sending you a phial of the milk, together with a few leaves, and a portion of the root of the tree. The *Palo de vaca* is a tree of large dimensions. The one that I procured the juice from, had a trunk seven feet in diameter, and it was one hundred feet from the root to the first branch. The milk was obtained by making a spiral incision into the bark. Carauo, the place where I met with the tree, is about fifty miles east of La Guayra, and at an elevation of from 1000 to 1200 feet above the level of the sea. It is likewise found between Cape Codera and Barcelona. The milk is used by the inhabitants wherever it is known. I drank a pint of it, without experiencing the least inconvenience. In taste and consistence, it much resembled sweet cream, and possesses an agreeable smell. I was so fortunate as to procure some young trees and roots of the *Palo de vaca*, which I will endeavour to increase, and, if I prove successful, you may expect to have a plant."

To these interesting observations, extracted from the Edinburgh Philosophical Journal, Mr. Don adds the following note. "I had an opportunity of examining attentively the leaves of the *Palo de vaca,* and found them to approach very close to those of several South American species of *Ficus.* The disposition of the nerves and veins was precisely similar, which, together with the insertion and consistence of the leaves themselves, appear to justify the propriety of the place assigned to the *Palo de vaca,* by M. Kunth, who has arranged it in the family of *Urticeæ,* under the name of *Galactodendron utile ;* but neither he nor myself have seen either the flower or fruit: so that as a genus, it rests on very insufficient grounds. The tree, however, is evidently related either to *Ficus* or *Brosimum.* The juice contained in the phial sent to Mr. Lambert had the appearance of sour cream, and, notwithstanding that it had suffered materially from the long voyage, the taste was by no means unpalatable."

Mr. Smith, in a communication to Professor Jameson, mentions a tree discovered by him, in an excursion up the river Demerara, possessing qualities very similar to those of the Palo de vaca. It is stated to be a tree from thirty to forty feet high, with a diameter at the base of nearly eighteen inches; the milky juice which exudes very abundantly on the tree being cut, was found to be thicker and richer than cow's milk, altogether without acrimonious properties, and mixing freely with water. It does not, however, belong to the same genus of plants as the cow-tree. Mr. Arnott examined a dried specimen transmitted by Mr. Smith, and proposes to call it *Tabernæmontana utilis.*

Mr. Fanning, who was in England in 1829, brought some specimens of the cow-tree, the first ever seen in Britain, together with a drawing of the tree: these plants however, unfortunately perished. He brought also, at the same time, some of the milk dried in the form of lozenges.

CHAPTER VIII.

Peculiar Secretions of Plants—Condensation and Retention of Moisture by Trees.

Apart from the more commonly secreted vegetable products of fecula, gluten and others; there appear to be some apparently more rare and extraordinary elaborations, besides those mentioned at the close of the preceding chapter.

Various indeed are the substances contained in, and discovered as secretions in plants, nor do we now advert to the proximate or immediate principles, as partially enumerated, but to alkaline earthy and metallic matters, sometimes under the form of salts. Silica is found in the epidermis of reeds and grasses, in the calamus rotang and equisetum hiemale, Dutch rush, or shave grass. Wood stone appears to be in some cases the secretion of vegetation: a mass of wood stone was some years ago torn from a log of teak wood, tectona grandis, in H. M. dockyard at Calcutta, and it seemed to be completely interlaced by the fibres of the wood. But the most curious secretion of this description is that called tabasheer. It is found in the joints of the female bamboo, bambusa arundinacea, and has been conjectured to be a morbid secretion, the consequence of the puncture of an insect: it has also been found in the bamboos reared in hot-houses, in this country. This singular production may be purchased in the markets of Calcutta: the best is called *patnai,* from its locality to Patna. Tabasheer is called by the Telingas, milk of bamboo, vedroo paloo; and by the Tamuls, salt of bamboo, mungil upoo: medicinal virtues have also been ascribed to it. The Hindoo physicians call it bamboo manna, or milk; it has also been termed sugar, or camphor of bamboo, and holds a place in the Sanscrit works on medicine. Though its discovery has yet been limited to a few kinds of bamboo, there can be no doubt that many others contain it. In the berry-bearing bamboo, a native of the mountains of Chittagong, tabasheer is also found, and as it would appear, in extraordinary quantity; the cavity between the joints being nearly filled with it, called by the natives *lime,* choonah. The best sort of tabasheer seems to possess a bluish-white colour. The quantity usually found in one joint amounts to about four or five grains, but as much as twenty grains have been found. When accurately examined, it seems to be an incrustation at the top or bottom of the cavity between the nodes, it appears to separate as it indurates, and finally rattles when the portion of the cane containing it is shaken. The tabasheer chemically considered, appears to consist of silicious matter, combined with a notable portion of lime and vegetable matter; but, according to others, is composed of 70 silica and 30 potassa. The quantity of water, which is absorbed by the tabasheer, exceeds the individual weight of the substance. It appears to vary in opacity and density. The specific gravity of the transparent variety is 2·402, and of the opake 2·050. When the oil of beech nut is applied to it, it becomes as transparent as glass: when water is, on the contrary, poured over the more transparent varieties, they become as white and opake as pure chalk, a fact curious in itself, and exactly the reverse of what we meet with in that interesting variety of semiopal, called hydrophane, which becomes transparent when put into water; I have indeed a specimen of the precious opal which possesses a similar property. The Chinese, it has been said, were once, perhaps now are, possessed of a method of making porcelain exhibiting some such extraordinary phenomena. This porcelain is described as being altogether opake, until water is poured into the cup or basin, when it exhibits opake fishes apparently floating in a transparent sea. The preceding facts render the phenomena by no means incredible, and may serve for its elucidation. When we consider these singular elaborations of vegetation, the ingenious conjecture of Professor Jameson, that the *diamond* itself may have been a vegetable secretion, seems by no means so improbable as at first sight it might appear to be. When the diamond is found in situ, there is generally a covering, at least, of vegetable earth; but when the ferruginous gravel, in which it is found, is washed down by the mountain torrent, we are deprived of the means of forming a correct estimate. Amber is unequivocally a vegetable secretion, modified by its associations and the circumstances under which it is found.

In the cellular tissue of an old trunk of the cereus peruvianus, in the Jardin de Plantes; M. Turpin found an immense quantity of agglomerations of crystals of oxalate of lime. These were found in the medulla, as well as in the external rhind. The crystals were transparent, and arranged in radiant groups. This plant seems to have been about 150 years old. Carbonate of lime is found in the sap of the vine, also in the bark of the chara vulgaris, and many pears; sulphate of lime is found in wheat and clover; phosphate of lime in the oat; nitrate of soda obtains in barley; nitrate of potassa in the sap of the sun-flower, and in tobacco; in the latter indeed it is so abundant as to make it a profitable concern to dig up the earthen floor where the leaves have been fermented, and to extract by washing the nitre, with which it is found to be saturated. Muriate of soda is found in many plants, particularly those that grow on the sea shore, or fringe the mountains that impose a barrier to the advance of the sea; the samphire contains muriate of soda, or common salt; and it always grows beyond the reach of the tides. Indeed salt springs may be easily discovered by the features of the peculiar vegetation which fringes them, such as triglochin maritimum, aster tripolium, salicornia, and glaux maritima. These are plants which are found connected with brine springs though inland; and are not otherwise found, save at the estuaries of rivers, or other parts of the sea shore. These all afford muriate of soda and other alkaline salts; and salsola kali, or kelpwort, is cultivated for the carbonate of soda supplied by its ashes. Various seed weeds are consumed for the same purpose; and the fern, with the stems, and leaves of the potatoe, will thus afford the carbonate of potassa. In the island of Lancerote, one of the Canaries, the beautiful ice plant, mysembranthemum crystallinum, affords a great part of the barilla exported from thence. The pustules or transparent vesicles which stud the leaves, and adds so much to their beauty and singularity, I found on investigation to be replete with liquid muriate of soda. By analysis I discovered in these leaves muriate of soda and muriate of potassa, also *iodine* and *bromine.* Bowditch, in his mission to Ashantee, mentions the circumstance of a particular cedar, the leaves of which transpire a considerable quantity of liquid salt, which crystalizes during the day: there is also in Chili, a plant which has been called saline basil, and though it be sixty miles distant from the sea coast, it is found to be every morning covered over with saline globules, hard and shining, imparting a remarkable character to the appearance of the plant, which at a distance seems to be covered with dew drops. Each plant supplies, day by day, about an ounce of fine salt, which is duly collected, and used as common salt, the natives esteeming it very much superior to common salt: no doubt they are correct in this preference, for it is not improbable that the muriate of magnesia, to which sea water and common salt owe their bitterness is entirely absent.

In the deserts of Arabia there is still found a peculiar secreted substance, somewhat of the character of manna; yet, appears to differ in many respects from it: it seems to be elaborated by a kind of tamarix, and to fall down to the ground, where it presents precisely the appearance of that described in the sacred volume. The Arabs collect it and use it as food. The asclepias syriaca is very remarkable for its secretion of saccharine matter. In 1816, I was shewn a quantity of this substance, sent to this country from Montreal, by the Countess of Selkirk; and received at the same time, a supply of the seeds which are imbedded in a soft and silky down. This saccharine matter was of the consistency of thick granulated honey, and possessed its taste and flavour. The following I have abridged from the manuscript account which accompanied it. The plant is called ‘ cotonnier,’ and succeeds best in a good soil. It comes up in the month of May, much in the manner of asparagus, and when nine or ten inches high is cut for the table. If left to grow undisturbed, it rises to the height of about three feet, and bears a flower, something resembling the lilac. In the month of August there is an abundant dew on the leaves and flowers, which continues for about a fortnight, or three weeks; this being shaken off into basins before or soon after the sun rises, a quantity of sweet liquor or syrup is collected, and this boiled down to a proper consistency, yields a sugar resembling honey in colour and flavour. The cotonnier is of a pale dull green. The pods when ripe are egg shaped, and contain a white silky substance like cotton, from which it takes its name. The Canadians use the cotton* as a substitute for feathers, to fill mattrasses and pillows. I have before me a communication from the late Sir James Edward Smith who thus notices the plant: " The *asclepias syriaca* of Linneus, is said by Clusius, &c., to grow in Syria; whether it does so or not, it grows wild in North America. The Americans make a great wonder of it for its copious honey, and tell many incorrect stories about it. The honey falling on the leaves, (from the flowers) gives the appearance of honey dew." We shall only further add to our selection, which might have extended much farther, the singular property of some berries obtained from a plant on the coast of Guinea, described by the Danish naturalists, Schumacher and others. The plant discovered by Schumacher is called *bomelia ducifera.* The berries, though tasteless, and insipid in themselves, impart an agreeable flavour to whatever is eaten or drank immediately after them: " Vinegar tastes like sugared wine, and the lemon like an orange."

Gaseous secretions wlll be adverted to in another place; but it may be here noticed, that a peculiar acid, much esteemed and prized by the higher ranks of Hindoos, is obtained on the coast of Coromaudel, by spreading pieces of muslin over the cicer arietinum, or flowering sennaga; these are spread after sunset, during fogs, and removed before the sun dispels them. The muslin is then wrung out, and the liquid is called *sennagalu vinegar,* said to be a compound of several acids, as the acetic, malic, and oxalic.

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* From an inspection of this product, and the cohesion of the fibres, I cannot doubt that it might be manufactured into an excellent thread, indeed, perhaps may have been so, as has already been done, we believe, in respect to the cotton grass, criophorum, so abundant in many of our bogs. Waggon loads of both are suffered to become the sport of the winds.

Almost all plants, besides alkaline and earthy matter, discover in their ashes oxydes of iron and manganese; in some the oxyde of copper has been discovered; and even gold has been detected in the ashes of the vine.

Liquid secretions of an aqueous character, have been already adverted to, in reference to the cephalotus and nepenthes; but in these cases, and perhaps also in that of the sarracenia adunca, they are obviously the secretions of the plant. There are others which may be now mentioned, that belong to the same class. When the calaethiopica, and the agapanthus umbellatus, are freely watered, limpid drops may be seen to distil from the tips of the leaves.

In Cockburn's *Voyages,* we find an interesting account of a tree in South America, which yielded a plentiful supply of water by a kind of distillery process: this tree was met with near the mountainous district of Vera Paz. The party were attracted to it from a distance, the ground appearing wet around it; and the peculiarity was the more striking, as no rain had fallen for six months previous. "At last," says he, "to our great astonishment, as well as joy, we saw water dropping, or, as it were, distilling fast from the end of every leaf of this wonderful tree; at least it was so with us, who had been labouring four days through extreme heat without receiving the least moisture, and were now almost expiring for want of it." A portion of the water-withe, a native of Jamaica, (vitis labrusca), a kind of wild vine, of the length of three or four feet, yields a supply of nearly a pint of water, which has saved many a traveller from perishing in the woods. Of a similar description appears to be that of a shrub discovered in our East Indian possessions;—from the stem of this plant, when divided, there issues a copious spring of limpid and wholesome water. The natives appear to be well acquainted with it. It seems to be a climbing plant, and perhaps a species of wild vine. Mr. Campbell, in his travels in South Africa, mentions his having met with a species of mouse in these parched regions, and was surprised to find it occupied in nibbling off the berries of a certain plant, and conveying them to its subterranean abode. On examining these berries he found that each contained about three tea spoonsful of water; so these little creatures were stowing them away, like sailors their water casks. In the Brazils is a bamboo, the young shoots of which are supplied with a limpid beverage, grateful to the Brazillian hunters. The water liannes, on the parched rocks of the Antilles, are full of sap, and water flows as soon as they are wounded. Water has been found as a secretion of the flower, in the moranta gibba, and among the scales which form the imbricated spike of the amonium zerumbet; the quantity of secreted water is considerable.

There are phenomena of another kind connected with the reception and condensation of moisture, and have nothing to do with the secretions of the plant. Sometimes the foliage, and at other times the stem or trunk, serve as vegetable tanks or reservoirs, to catch the condensed dews, or the falling rain, and retain the supply: the sarracenia purpurea, for instance. To these might be added the dischidia rafflesiana, and clavata; one of which is found in the Indian archipelago, and the other on the coast of Martaban. These are climbing plants, having long slender voluble stems, with here and there roots springing from them; from these slender woody stems, by which they ascend to the summits of the loftiest trees, are suspended the pouches, or ascidia, in the form of large yellowish green bags, in pendant bunches. In the norantia, which are small trees found in the mountainous districts of the Brazils, particularly in the minas geraes, and serra dorada, the ascidia* are in the form of diminutive coloured hollow vesicles, pendant or erect among the flower. In the marcgraavia umbellata, a native of the west Indies, there are also pouches or sacs containing liquid matter.

The leaves of the teasle embrace the stem, and from their union, form a hollow cup which retains water. The foliage of the wild pine, tillandsia, of the West Indies, and South America, are so concave as to contain a great deal of water; and Dampier mentions that his thirst had frequently been allayed by perforating these leaves, and receiving the water below. In Africa, is a tree called boa, whose vast trunk, hollowed like a cistern, receives and retains the dews; and wherein the water is preserved from evaporation by the overshadowing foliage. Sloane also mentions an aloe, which contains a sufficient quantity of water, in its hollow leaves, to afford a refreshing stream to the weary traveller. The birch-wort of Canada, is supplied with two leaves resembling the halves of a bell or trumpet, with a depression in the form of a natural spout or lip. These hollow leaves afford a plentiful supply of pure water to the animals of the district. Prince Maximilian, in his *Travels in the Brazils,* informs us that the natives in these districts are well acquainted with the peculiar property of those hollow leaves that act as recipients of the condensed vapours of the atmosphere; a Puri taught them that from the stiff middle leaves of the bromelia shrub, water might be obtained sufficient to satisfy thirst; and, doubtless, these are sources where many tropical animals, as well as the wandering savage, sate their thirst "in a weary land." These are indeed "pools in the desert;" and it must forcibly strike the contemplative mind as very remarkable, that succulent plants should be found, where *we* should least expect to meet with them. That an infinitely wise Intelligence should have so formed vegetation, as to minister its supplies; and so moulded its foliage as to become so many cisterns, or reservoirs of water: living fountains, to quench the thirst of the great tide of animation which swarms in tropical countries; and without which they would certainly perish. In no region of the globe is there wanting traces of remarkable design—creation teems with such—it is full of miracles. When the adventurous Mungo Park had been stripped and plundered, in the desert, fainting for thirst and want of food, weary and ready to die, he had almost resigned himself to despair, when a providential incident turned the current of his thoughts into a happier channel—" at this moment," says the traveller, " painful as my reflections were, the extraordinary beauty of a small moss, in flower, irresistibly caught my eye. I mention this to shew from what trifling circumstances the mind will sometimes derive consolation; for though the whole plant was not larger than the top of one of my fingers, I could not contemplate the delicate conformation of the roots, leaves, &c., without admiration. Can that Being (thought I) who planted, watered, and brought to perfection, in this obscure part of the world, a thing which appears of so small importance, look with unconcern upon the situation and sufferings of creatures formed after his own image? Surely not! Reflections like these could not allow me to despair: I started up, and disregarding both hunger and fatigue, travelled forwards, assured that relief was at hand; and I was not disappointed—in a short time I came to a small village."—When therefore we ' consider the lilies of the field how they grow,' may we not exclaim, in the language of Harvey, the immortal discoverer of the circulation of the blood, that we shall indeed find God equally manifest in the humbler as in the higher ranks of creation? To the same effect are the words of Linneus, the prince naturalists :—“ Legi aliquot Dei vestigia per creata rerum, in quibus omnibus, etiam in minimis, ut fere nullis, quæ vis! quanta sapienta! quam inextricabilis perfectio!”

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* The liquid is said to be sweet in some, and bitter in others.

Ancient writers mention a tree which attracted the clouds from the heavens, and resolved them into rain in the desert. Relations like these have, however, been considered fabulous. In the Brazils, there is a tree the young branches of which distil water like a shower. This tree has received the name of *cubea pluviosa.* Sir J. E. Smith found in Italy, that willow groves shed water like gentle rain. The calamus rotang, and others, at the season of sap, also weep abundantly. That trees by their foliage condense the vapours of the atmosphere, we have abundant proof. In Glas’ *History of the Canary Islands,* we have the description of a tree in the island of Ferro, one of the western islands of the Canaries, which supplies the inhabitants, man as well as the inferior animals, with water; an island which, but for this marvellous provision, would be uninhabitable and abandoned. The tree is called *til* by the people of the island, and has attached to it the epithet *garse,* or *sacred.* It is situated on the top of a rock, terminating the district called *Tigulatre,* which leads from the shore. A cloud of vapour, which seems to rise from the sea, is impelled towards it; and being condensed by the foliage of the tree, the rain falls into a large tank, or rather two large cisterns, which are constantly replenished by this fountain tree. One of these is set apart for the supply of the inhabitants of the island, and the other is appropriated for the use of the cattle, from which it is measured out by individuals, set apart for that purpose, by the authorities of the island. This very interesting and extraordinary tree is the *spartium nubigenum*. A cloud of vapour rests incessantly on its summit, and its foliage constantly distils water; it is hence called the *raining tree*, and affords an abundant supply for the people of the island;—"themselves, their little ones, and their cattle." The trunk of this tree is about three feet in diameter, and does not exceed thirty feet in altitude. The circumference of the extremities of the branches is one hundred and twenty feet; the branches are considerably extended, and the leaves somewhat resembling those of the laurel, are curved. Among the high mountains of South America, the trees constantly transpire a quantity of water, even in the driest weather; this water being sometimes so copious as to fall like rain. I may now mention a phenomenon founded on the same principles, and of which I was myself an eye witness. I had frequently observed, in avenues of trees, that the entire ground engrossed by their shady foliage was completely saturated with moisture; and during the prevalence of a fog, when the ground without their pale was completely parched, the wet which fell from their branches more resembled a gentle shower than anything else; in investigating the phenomenon, which I am disposed to consider entirely *electrical*, I think the *elm* exhibits this feature more remarkably than any other tree of the forest. I never, however, was more astonished than I was, in the month of September, a few years ago, on witnessing a very striking example of this description. I had taken an early walk, on the road leading from Stafford to Lichfield : a dense fog prevailed, but the *road was dry and dusty,* while it was quite otherwise with the line of a few *Lombardy poplars* ; for from them it rained so plentifully, and so fast, that any one of them might have been used as an admirable shower bath.

It will be remembered that oases,—these "islands of the desert," are characterized by groups or groves of palm trees or mimosas; and there wells are found : the great rivers of the continent of Europe have their source of supply in the glaciers ; but many of the rivers in the New World owe their origin to the extensive forests of America ; their destruction might dry up many a rivulet, and convert the luxuriant valley into an arid and sterile waste ; carried further, the principle extends to the great features of the globe. What the glaciers effect among the higher regions of the Alps, the pinus cembra and larix communis, accomplish at lower elevations ; and many a mountain rivulet owes its existence to their influence. It rains often in the woodlands when it rains no where besides ; it is thus that trees and woods modify the hygrometric character of a country ; and I doubt not but, by a judicious disposal of trees of particular kinds, many lands now parched up with drought ; as some of the Leeward Islands now are—might be reclaimed from that sterility to which they are unhappily doomed. The very climate of a country may thus be essentially altered, and no doubt has actually been changed, since its woods have been felled, as in Scotland. In America, many rivers have been dried up in districts where forests have been cut down.

CHAPTER IX.

Parasitic Vegetation—Air Plants—Extremes of Temperature in relation to Vegetation.

ALTHOUGH earth and water have been regarded as the sources from whence vegetation receives its supplies, we shall find some plants preying on others, completely parasitic; sometimes on the root, occasionally on the trunk and branches, and at other times on the leaves. Another class appears to spring up from their remains, and draw their sustenance from their decomposition: while a third class seems to fasten upon or cling to trees, chiefly for the purpose of a local attachment. The former are called parasites, the latter epiphytes. In illustration of the latter we may mention that the epidendron grows on the stem of the sterculia balangas: the dendrobium picrardii also fastened to a tree, and artificially irrigated, succeeds.

Some parasites appear to live, from first to last, on the stocks where they are discovered; others again seem to rise from independent roots in the soil, and afterwards becoming attached to the stranger, their original roots wither away: parasites also seem to spring originally from a stock, and as soon as they are nursed by the foster parent, strike out roots of their own. The misseltoe clings to the branches of trees. The dodder attaches itself indiscriminately to various plants; the nettle, hop, and thyme: the orobanche grows on some roots, as that of hemp. Orchideous epiphytes grow naturally on trees in the deep recesses of tropical forests, and have often a very remarkable character. Sometimes they are discovered on the junction of branches; and in other cases flourish among masses of decaying animal and vegetable matter; or on rocks and stones. We shall however limit our selection from this very remarkable department of vegetation: once small indeed in the number of its tribes, but now considerably extended by the enterprise and indefatigable research of modern botanists. Some orchideous plants are terrestrial, but among them are found numerous extraordinary parasites. Perhaps the Horticultural Society of London possesses the most extensive and rare collection of orchideæ in Europe; not less than one hundred and eighty tropical species alone. In Dr. Wallich's work there will be found figured a beautiful dendrobium, a fine example of this singular class of plants: the maxillaria picta is also a fine flower; it is a native of the Brazils. The petals are a rich deep orange, spotted with purple: it is strictly parasitic. The prescotia plantaginea is a most remarkable plant; the flowers, which are of an herbaceous green colour, remain long unaltered after their functions appear to have terminated; it was found parasitic on the stems of fallen trees in South America. The catasetum cristatum, another bulbous rooted parasite from Bahia de St. Salvador, has also green flowers; the habit of another of these orchideæ, is quite peculiar and unique: it is called nanodes discolor; the leaves are green and purple, and the flowers are so like the leaves "among which they spring, and by which they are embosomed, that you would scarcely discover the plant to be in flower, even if every branch was blossoming." The stanhopæa eburnea, another of these singular epiphytes, was introduced into this country from Rio de Janiero: the flowers appear to be slightly fragrant and short-lived; "the lip of the flower, when fresh, appears to be formed of the most pure and highly polished ivory;" the tillandsia, or wild pine of the West Indies, has been already adverted to, for its singular seeds supplied with threads by which it coils round the branches of trees, and thus forms its attachment until vegetation supervenes.

Among the most extraordinary discoveries of modern times, fertile as our era has already been in the fruits of research, is that of the rafflesia arnoldii; discovered in the year 1818, by Dr. Arnold: its generic name is a very just compliment to the late Sir Stamford Raffles, and the specific name to that of its discoverer. Plate I. figure 5, represents this extraordinary parasite found in the island of Sumatra. The circumference of the fully expanded flower is NINE FEET, being a yard in diameter. The nectarium was computed to hold twelve pints; and the entire weight to be 15lbs. The petals or segments, which are five in number, are about twelve inches long, and vary from ¼th to ¾th of an inch thick. The colour of these petals is brick red, covered with yellowish white protuberances. I have seen a fine wax model of this magnificent titan of the vegetable kingdom, in the rooms of the London Horticultural Society; and there are buds in the Linnean Society's Museum: the flower fully blown was discovered in a jungle under some bushes, close to the ground, with a swarm of flies hovering over the nectarium, and apparently depositing their ova in its substance; the late Dr. Arnold thus announces its discovery in a letter to a friend:—"At Pulo Lebban, on the Manna River, I rejoice to tell you, I met with what I consider the greatest prodigy of the vegetable world. I had ventured some way before the party, when one of the Malay servants came running to me, with wonder in his eyes, and said, '*Come with me, sir, come! a flower very large, beautiful, wonderful!*' I went with the man about a hundred yards into the jungle, and he pointed to a flower growing close to the ground, under the bushes, which was truly astonishing. My first impulse was to cut it up and carry it to the hut: I therefore seized the Malay's parang, (a sort of instrument like a woodman's chopping hook,) and finding that it sprang from a small root, which ran horizontally, (about as large as two fingers), I soon detached it, and removed it to our hut. To tell you the truth, had I been alone, and had there been no witnesses, I should, I think, have been fearful of mentioning the dimensions of this flower, so much does it exceed every flower I have ever seen or heard of; but I had Sir Stamford and Lady Raffles with me, and Mr. Palsgrave, who, though equally astonished with myself, yet are able to testify as to the truth.

"The whole flower was of a very thick substance; the petals and nectary being in few places less than a quarter of an inch thick, and in some places three quarters of an inch: the substance of it was very succulent. When I first saw it, a swarm of flies were hovering over the mouth of the nectary, and apparently laying their eggs in the substance of it. It had precisely the smell of tainted beef.

"Now for the dimensions, which are the most astonishing part of the flower. It measured *a full yard across;* the petals being twelve inches high, and a foot apart from each other. The nectarium, in the opinion of us all, would hold twelve pints; and the weight of this prodigy we calculated to be fifteen pounds!"

This wonderful flower proved to be a male blossom, for the flower is diœcious. Before it expands, it presents the semblance of an enormous cabbage enveloped in purplish or brownish bracteæ. A fine coloured engraving of the expanded flower is published in the Transactions of the Linnean Society, as well as several plates, representing the appearance of the unexpanded bud and sections. This titan of vegetable creation grows indiscriminately on the stem or root of a species of vitis or wild vine, (cissus angustifolia of Roxburgh,) and other allies, attached like cables to the trees of tropical forests. It is itself alone, and complete within itself, every thing being enclosed within the folds of its bracteæ. It is a flower and nothing but a flower—no plant owns this blossom; and it claims no plant for its possession. It is an independent flower, but having almost nothing in common with other flowers: and though a parasitic decoration, it has neither leaf nor stem nor root: it is a vegetating blossom, that has fastened on a recumbent vine, and drains its vitals. From the first appearance of the flower bud, to the full expansion of the flower, is a period of three months. It is emphatically called by the natives, ambun ambun, or, krubut, or great flower. The pistils of the male flower sent to England are represented to be as large as cows' horns. The appearance of the male and female flowers do not differ, save that anthers are found in the former. This extraordinary flower appears, from more recent information, to be less rare than was at first supposed. At the close of the rainy season, it makes its appearance, and but once a year. As the flower unfolds, the bracteæ wither; and soon after its expansion the blossom decays. Dr. Horsfield met with a pigmy species of this flower, but it measured only three inches in diameter. The rafflesias do not develop seeds; but, like mushrooms, are reared from spores contained in the pulpy mass. Another distinct species of rafflesia has since been discovered in a small island called Nusa Kambangan, to the south of Java: it has received the name rafflesia patma, in reference to its place of growth; and the natives call it patma. This species, which is quite characteristically distinct, is figured in Dr. Blume's 'Flora Javæ.' It is two feet nearly in diameter, or six feet in circumference. The rafflesia patma, like its kindred species, is also truly parasitic: it grows on the root of the cissus scariosa, and, according to Dr. Blume, is connected only with the *bark* of the root, being without contact with the woody part of the root. The bark, by the insertion of the neck of the rafflesia into it, is formed into a cup, which varies in diameter, increasing with the evolution of the flower, until its final decay. Another remarkable parasite of the same class, is figured in the Flora Javæ, but is a distinct genus: it has received the name of brugmansia zippelii; the specific name being derived from that of its discoverer. It was found growing on the roots of the cissus tuberculata of Blume, at the height of from 1200 to 1500 feet above the level of the sea; in the province of Buitenzorg, on the mountain Selax,—to the W. of Java.

The orobanche is a parasitic plant. One species attacks the roots of hemp, cannabis sativa, and destroys it. The orobanche major has been reared from seeds on the root of the broom, hence called broom rape, it is parasitical, though it also sends forth roots into the soil. Mr. Keith states he has found it parasitic, both on the root of the scabiosa arvensis, and samolus valerandi. The orobanche minor is met with in clover fields, and apparently unattached to other plants. In gardens it may be found affixed to the stems of prenanthes muralis.

The dodder, cuscuta europea, the seeds of which are generally mixed with those of Dutch clover, attacks several artificial grasses, as well as trefoil and lucerne. One of this tribe fastens on the vine, and its thready fibres are as large as a packthread; this however, is rather rare. In the first instance, the dodder can scarcely be called parasitical. The seed falls to the ground, takes root in the earth, and it elevates its stem in the atmosphere, taking hold of the first plant that comes to hand, as thyme, thistles, flax, beans, &c., though it appears to be particularly attached to hops and nettles. When it has fairly laid hold of the plant, by means of its parasitic roots, or glandular suckers, its terrestrial root withers, and it then becomes truly parasitic; so that it has two distinct existences, terrestrial and aërial. The dodder sometimes resembles a confused knot of threads or fibres, so that the plant is a *mere stem*, without leaf or root. Gerrard, in his quaint manner, describes it as "a strange herbe, altogether without leafe or roote, like unto threads very much snarled or wrapped together, confusedly winding itself about bushes." There are, it is stated, twelve species of dodder, five of which are perennial. The dodder has an odd appearance with its red threads twining round branches, and its pendant festoons of flowers, imparting to the plant a singular and fantastic finery. The seeds of the dodder, after having escaped from their capsules, take root, in early spring, and as soon as the hop buds appear above ground, they are seized on by the spiral convolutions of the dodder, which fasten on the stem of the hop: the plant then changes its sickly and emaciated hue to a healthy aspect and condition, and seems to riot on the juices of the hop, while its earthly attachments are dissevered.

That parasite, the well known misseltoe, viscum album, which is used to decorate houses both within and without, at the season of Christmas, a practice we have also noticed abroad, is generally found on the apple tree, more rarely on the oak, and other trees. In the Herefordshire orchards, we have noticed it as very common; but do not remember ever to have seen it in Scotland, except in the garden of Mr. Neill at Cannon-Mills, where it was artificially introduced; though its luxuriance was by no means comparable with what it frequently attains in England. The seed of the misseltoe is, when ripe, a soft berry, white and glossy, about the size of a pea. By means of a glutinous exudation it readily adheres to the trunk, or branch of a tree, where it germinates. The great agent in planting these curious seeds is the 'misseltoe thrush,' hence indeed its specific apellation. A globular form attached to a stalk emerges from the seed, and in process of time, bends toward the branch; small fibres now spring from it, these introduce themselves into the bark, and live upon the juices of the tree. The misseltoe is a perennial evergreen, and is particularly remarkable when exposed by the denudation of the foster parent. When the latter is leafless and naked, the nursling of the storm, the misseltoe continues to flourish and to flower; and at Christmas, displays its white berries in abundance. According to the observations of Duhamel the roots penetrate the bark merely, and not the wood, and though the fibres be subsequently found to interlace the wood, it is merely that portion of new wood which has since been formed, as a deposition from the inner surface of the young bark or liber; the roots however are capable of completely penetrating the bark, in all its depth. The misseltoe has been also found on the pear, hazle, hawthorn, maple, willow, ash, elm, and the service tree. The cherry laurel will also support the misseltoe, and it is found in abundance on the lime trees, in the avenues of the Home Park at Windsor. It is worthy of remark, that each seed contains two plants. Mr. Dovaston, who has made many ingenious experiments on parasitic vegetation, placed the ripe berries, immediately when gathered in January, on the external surface of the bark of apple trees: some were inserted, others placed over, others laterally, and some under the branch; all however indiscriminately vegetated. The viscid or muscilaginous matter, that enveloped the seed, either dried up, or gave alternately, as affected by atmospheric moisture or drought. The entire number were full two years before they shewed any inclination to exfoliate, and it seemed as if the bark of the tree beneath, during these two years, became fretted, hectic, and as it were inflamed for a considerable length. In the third year they made an effort at foliation, by protruding two, and in some, four of their stiff, angular, sallow, and magical leaves. This account of the germination of the misseltoe, for which I am indebted to Mr. Dovaston, is very curious, and shews the action of the parasite on the bark, as in the case of the rafflesia. Of this extraordinary parasite, formerly called *misseldine*, Dr. Borlase, speaking of the Druids, says, they held it sacred, and were not to approach it but in the most devout and reverential manner. Towards the end of the year, they went in solemn procession to gather it from the oak, where however it is seldom found, to present it to Jupiter, with an invocation to all the world to assist at the ceremony. They had the misseltoe in great veneration, it was termed the universal remedy, and their sacrifices and religious festivals, were held beneath the oak, whereon it grew. Two white bulls, never yoked, were led forth, and the priest or arch-druid, clothed in white, ascended the oak and cut the misseltoe with a golden hook, while a white garment was spread out beneath it, to receive it as it fell. From this a kind of catholicon was formed, which cured all manner of diseases, and was an antidote to poisons. This plant being of a bright yellow, Virgil compares it to the celebrated golden bough of the sybil.

> 'Quale solet sylvis brumali tempore viscum
> Fronde virere nova, quod non sua seminat arbos,
> Talis erat species auri frondentis opaca
> Ilice.'*

It should seen that Virgil places the misseltoe on an evergreen. This singular plant is supposed to be the passport of Æneas. Its rarity on the oak, perhaps, determined the selection of the Druids to that of the oak, which would necessarily in that case share in the veneration. While the true misseltoe, loranthus europeus, flourishes on the oak among the mountains of Arcadia, our misseltoe, viscum album, in classic Greece, takes up its abode in the silver fir. The rafflesia, brugmansia, orobanche, dodder, and misseltoe, are genuine *parasites,* that is to say, they unequivocally feed and live on the plants where they are discovered. The dodder, as well as the orobanche, though not parasites in the first stage of growth, become so. There are various others, and among them many cryptagamous fungi, which prey on plants, and often occasion their complete destruction. That called *rust* is occasioned by a parasite, that attacks grasses. Mildew, blight, smut, brands, blacks, &c. are all occasioned by the attacks of parasitic vegetation—chiefly the reticularia, so called from the magnified tunic appearing to be of a reticular structure; termed uredo. Those also called dust brand, canker brand, pepper brand, &c. belong to the uredo. The canker brand, or pepper brand, uredo fætida, attacks wheat; and the smut, or dust brand, uredo segetum or uredo carbo, attacks all indiscriminately. The canker brand, uredo fætida, is very subtile, and its operations are unseen; but the dust brand, uredo carbo, soon shows its influence externally, penetrates the culm to the centre, while the plant seems under this visitation, to be distorted and degenerate, and powdered over or dusted, with carbonaceous matter; hence the names, dust brand or pepper brand, from the appearance the diseased culm and ear present. The rhizoctonia is a sort of parasitic tuber which attacks the roots of lucerne and saffron, and in the latter case, the effect is so fatal that it has received the name of 'death.' To this class belong what are commonly known under the names of mildew and moulds. The leaves of the barberry, pea, clover, &c. manifest this parasitic visitation, and the first of these has had the blame of infecting the corn field in which it happens to be placed. Such leaves appear dusted or spotted. Among the most interesting of this kind of parasitic attack, is that peculiar attachment sometimes found on the spike or ear of rye, called 'spur' or ergot of rye; technically *secale cornutum,*—and in France, siegle ergoté,—now found to be a most valuable medical agent. This parasitic disease communicates to the bread made from rye flour, very deleterious properties; and in many cases, in the south of France, we understood it to have been destructive to entire families. The bread thus infected is easily recognized; it is full of *violet spots.* My friend, Mr. Fryer, of Bewdley, gave me an ear of spurred rye, taken from a field in Worcestershire, and the spur was as large as any I have ever seen in France. While the secale cornutum, or spur, so called from its peculiar form, preys on the rye, itself soon becomes the victim of parasitic animalcular attack; hence the extreme difficulty of preserving it, otherwise than in tincture, &c. I have observed a beautiful parasitic vegetation on the thread like stems of the linaria cymbalaria—a byssus.

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* Æn. VII. l. 305.

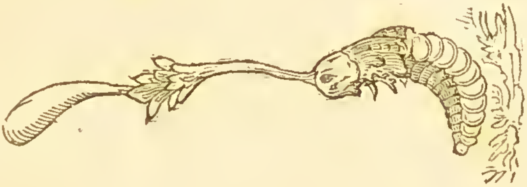
Among the class of parasites, has been ranked the greater toothwort or lathræa squamaria, a very curious and interesting plant: though I confess I have my doubts about its clear title to the distinction of parasite. A correspondent of the Magazine of Natural History, says, he never met with it parasitic but once, and that on the root of the ash. I have seen it growing in a garden in the earth, at Mansfield. By far the most complete natural history of this curious plant is that by Mr. J. E. Bowman, in the Transactions of the Linnean Society. Mr. Bowman favoured me with a beautiful drawing of the plant, from which the diminutive figure 16, plate II. was copied, and as this was accompanied with a description of the plant, I shall now give the detail in the words of that communication. "The lathræa squamaria forms one of a natural family of plants, parasitical on the roots of various trees, of which orobanche, the monotrapa, hypopithys, and the ophrys nidus avis are members, though not congeners, in the naturalsy stem of Linneus. They are singular and interesting from being destitute of leaves, and the slightest tinge of green; brittle and succulent, and altogether of a brown or yellow colour. The lathræa is generally parasitical on the roots of the hazel, and is found, though rarely, on the margin of streams at the foot of steep acclivities, in a northern aspect, where not only the direct rays of the sun never penetrate, but where the overhanging trees, from whose roots it derives its support, involve the surrounding atmosphere in a perpetual shade. In such situations, about that period of the spring, when the flowers of the allium ursinum burst their sheathe, this pale and sickly stranger may be seen obtruding itself through the light mass of vegetable matter which thickly covers the soil, presenting to the observant eye of the naturalist a singular combination of beauty and disease. Not a leaf or the slightest tint of green enables it to vie with its gay associates of that lovely season; and but for an occasional faint dash of purple on its stem and its half-concealed and folded pink petals, it is of an uniform ochery and cadaverous hue. The flower stem alone appears above the surface; and if it possess any leaves, they are the closely imbricated and fleshy scales below, which gave it the name of squamaria among the older botanists, and from their close resemblance to the human teeth, its English appellation of toothwort."

"They are similar in colour and texture to the other parts of the plant; and on turning up the soil exhibit a densely entangled mass, often extending over a considerable space, and throwing up thirty or forty stems within a circle of a yard diameter. Luxuriant specimens attain the height of ten inches, with three rows of closely set flowers, all pointing one way on the same stem; but those on different plants in the same group are turned promiscuously towards all points of the compass, and indifferently towards or from the light. The specimen from which the accompanying drawing was taken grew in Erthig Wood, near Wrexham, a spot rich in botanical rarities, where this curious parasite is found in great profusion and luxuriance, and were these observations were made."

So far the parasitic vegetation has been confined to plants preying on their kinds, but we find vast varieties of algæ and fuci on the shells of mollusca; and those of the crustaceæ, as crabs and lobsters. The following however are still more remarkable. Dutrochet found a small moss (conferva?) growing on the tail of a fish. In Lock Venacher, in Scotland, the pike are said to be loaded with confervæ. I am indebted to the friendly communication of Dr. Dugard, of Shrewsbury, for the following detail of some singular parasitic attacks on the animal kingdom by confervæ. 'The curious circumstance I mentioned of confervæ growing from the eyes of some perch, which produced blindness in the fishes, is a fact told me some years ago, by Mr. Middleton, a gentleman farmer, and an intelligent man, the proprietor of a pond he made in his garden, and stocked with perch, a few years prior to this discovery: the garden and pond are in a bog.' Dr. D. continues, 'I took a water newt from a pond, and kept it in some of the pond water several weeks, in a large flint glass jar, to observe its habits. The reptile was frequently changing its situation from the bottom to the top of the jar, probably to breathe, and was covered over so thickly with confervæ, that its size was very large, apparently, and observers could never make out from this singular disguise, 'what horrid creature I had in the water.' It should be observed that the water was never changed from its being taken in the first instance, from the pond.'

Equally remarkable is the parasitic attacks on insects by vegetation. We have long observed that some insects in the cabinet, have been found infected with minute fungi, or other cryptagamous plants, of a diminutive kind, but this has been regarded as the parasitic attack of vegetation after the death of the insect, on its partial decomposition, and several species of fungi have been found on the larvæ of insects. Ricord, however, observed in Guadaloupe a nest of wasps, the greater number of which were loaded with parasitic vegetation, and such was the encumbrance, that some on quitting the nest fell to the ground, and could not rise again in consequence of this singular burden. It is mostly confined to the breast bone. Ricord traced the rudiments of the plant to the larvæ of the insect, so that it 'grows with its growth, and strengthens with its strength.' This plant appears to be the sphæria entomorbiosa. That curious species of wasp, found in Jamaica, called 'vespa crinita,' and figured in the Transactions of the Royal Society, in all probability, owes its fantastic appearance to a diminutive vegetation of the same kind, a species of filiform fungus. There is a Spanish drawing of an insect, as represented in the figure, flying with a species of trifoliated plant on its back. "In the month of May," according to the original account transmitted of the *Vegetable Fly,* as it was called, "it buries itself in the earth, and begins to vegetate. By the end of June it arrives at its full growth and resembles a coral branch. It is about three inches high, and bears several little pods, which dropping off become worms," &c. All this is now known to be fabulous, and very much a counterpart of the speculations of St. Vincent, and others of the French school. Accurate investigation has shewn, agreeable to our previous remarks, that this parasitic vegetation attacks the living insect, and is even to be discovered in the larva form. According to Dr. Hill' who particularly examined these insects, there is in Martinique a peculiar fungus of the genus *clavaria,* different in species from all others, it has been termed C. sobolifera. The larvæ bury themselves beneath dead leaves, for their metamorphoses, many perish, and the

seeds spring from the dead insects. The subjoined figure was taken from a specimen in the British Museum, and figured in the Trans. R. S.



It is evidently the larva state of a species of vespa, and I have compared it with a specimen in my own cabinet, which has been very cautiously preserved in a neat little glass box. In my specimen, the vegetation, from the head is bifurcate, and nearly two inches long. Decandole found in the larva of the may bug, melolontha, from Virginia, transmitted him by Dr. Mitchell, a simple cryptagamous plant; while another from Jamaica, a full grown sphinx or hawkmoth, had the whole body covered with a vegetable crop. It by no means appears either that this parasitic attack is confined to one species of insect, or limited to one kind of plant.

Animals in their turn attack vegetation—a very common source indeed of the injuries to which plants are subject, such as the pine bug, aphis lanigera and others; but the most curious attachment is that of mollusca to the roots of the mangrove, &c. James mentions that shellfish attach in great quantities to the branches of the trees which droop into some of the great rivers in America. I have part of the root of a mangrove, with the shell of the ostrea ſolium, grasping it with its curious claw-like concretion.

It is well ascertained that many plants are more properly the subjects of the atmosphere, than the tenants of the earth or water. Some lichens creep along the arid rock, others cling to the bark of trees; sedums will grow when insulated from the earth, and even many of the cacti, when partially covered, and suspended in the atmosphere, will grow. The aloe may be occasionally seen presenting this remarkable character, its truncated stem being wrapped up in tarred or oiled canvas; and hung from the ceiling. I remember one case of this kind, in which the aloe had continued to grow for nearly twenty years. Sherrock notices this fact of the growth of the aloe, for he says that aloes being wrapped up in a cloth dipped in salad oil, and hung up, grow, but diminish in size and weight.

The most remarkable instance of this kind I ever remember to have witnessed, was the case of the ficus australis, which Mr. Macnab, the present eminent curator in the botanic garden of Edinburgh, had gradually detached from the pot in which it grew. Its roots were ultimately entirely denuded of earth, and the plant suspended in the air, and attached to the rafters. After this denudation had been effected a twelvemonth, it carried a crop of figs, at which period I saw it. Mr. Macnab also succeeded in the same way with a strelitzia reginæ, which I also saw, as well as a similar phenomenon in Mr. Neill's hothouse, at Cannon-Mills, of the ficus elastica, the roots of which simply grasped the wall. Colonel Welch gives a curious account of a banian tree, ficus religiosa, under peculiar circumstances of this kind. "At Trichoor," he observes "the rajah's palace is very large, and well built, and has an excellent garden within the fort, which is now in ruins; but the gate and draw-bridge are entire, and by them is the only road to the palace. On one of the bastions stands a teak flag-staff, thirty years' old, with a banian tree, of twenty years' growth, half way up it, the roots of which are dangling in the air. This I considered such a curiosity as to make a sketch of it on the spot. I pretend not to account for such a phenomenon, but the fact is as I have stated it; and the staff to which the tree is attached is so solid that I could hardly make any impression on it with a knife."

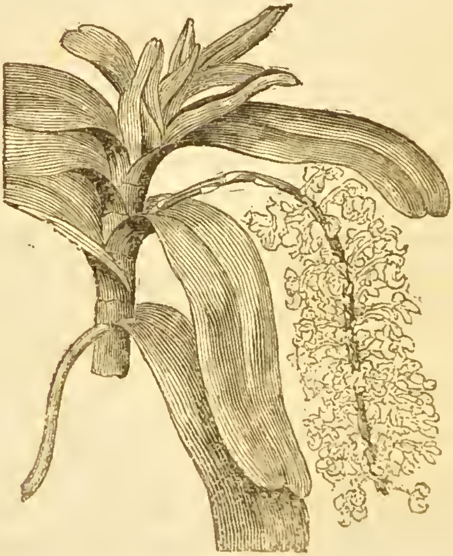
This singular tree has sometimes enclosed the trunks of other trees, and it then receives from the natives the name of the 'wedded banian.' Dr. Wallich communicated a curious phenomenon respecting the banian, to one of the editors of No. VIII. of that ably conducted work, the "Edinburgh Cabinet Library." 'A banian tree, in the botanic garden at Calcutta, had extended a branch across one of the walks: in due time a support thrown out by the branch, took root, and grew into a trunk on the opposite side of the walk. The original branch, now the connecting medium between the two trunks, happening to decay, an order was given for its removal; but it was ascertained that the offspring, finding the link between itself and its parent about to give way, had actually begun to send forth a healthy shoot along the centre of the decayed and yielding substance:' it is added that, on this discovery, the order was rescinded, and the trees are now united by 'what may be metaphorically termed reciprocal affection.' Mr. Forbes mentions a singular phenomenon connected with this very curious tree: 'on the inside of a large brick wall one of these trees lined the whole circumference of the internal space, and thus actually became a tree turned inside out.' These circumstances shew something extremely singular in the physiology of the 'ficus,' and tend to elucidate the curious fact recorded by Colonel Welch.

The roots therefore of these aërial trees seem to forego their functions, and the trunk must be supported in some other manner. It may be mentioned, as remotely connected with the present question, that a stake driven into the ground in St. Catherine's Estate, Jamaica, vegetated, and grew into a tree; in process of time, however, it was discovered that the root had become completely silicified or agatized. A narrow leafed myrtle was attached by inarching to two others; on one side it was connected with a broad leafed myrtle, and on the other with a box-leafed myrtle. In the mean time, the narrow leafed myrtle was separated from the pot in which it grew, and I saw it thus suspended between both, with its roots dangling in the air, and apparently receiving no detriment from its changed condition.

In tropical regions are some beautiful epiphytes; by this term, we mean plants that simply grow on other plants: are indebted to them merely for their locality, but they cannot be called parasitic, for they do not appear to draw their support from them, like the rafflesia and misseltoe. In this class, for instance, we find those singular specimens of vegetation which are called 'air plants,' and perhaps two of the most beautiful and interesting among these epiphtyes, or air plants, are the scarlet air plant, a diminished panicle of which flower will be found represented in plate II. figure 2, and the 'horned air plant.'

The scarlet air plant, renanthera coccinea, belongs to the natural order of orchideæ. Our knowledge of this magnificent plant has, until lately, been exceedingly imperfect; mainly depended on the reports of travellers; and the account published by the missionary Loureiro, in 1790, with a drawing. The beauty of its blossoms surpasses every thing known in the vegetable kingdom. That the Chinese suspended in baskets from the ceilings of their rooms, several of the tribe of plants to which the present specimen belongs, some for the sake of their beautiful flowers, and others on account of their fragrance, is familiar to all. From time to time, floriculture has gained several rich acquisitions of this description; but until recently, their inflorescence has bid defiance to the skill of the horticulturist. The scarlet air plant appears to have been included in almost every collection, containing orchideæ, and may have been frequently seen attached to a damp wall, or other support. The cause of failure appears to have been occasioned by the plant being preserved in too dry an atmosphere. Accordingly Mr. Fairbairn, gardener at Claremont, having tried the experiment of tying moss round the stem, and keeping it constantly moist, while exposed to the full sunshine, happily succeeded in inducing it to flower. This it did in October, 1827, in the hothouse at Claremont, having a rich and dazzling panicle of scarlet blossoms two and a half feet long. This epiphyte is a native of the woods in Cochin-China, where it climbs over trees. When it flowers, the plant may be safely removed to an apartment, where its magnificent blossoms, which are very durable, will remain in perfection many weeks. The scarlet air plant is beautifully figured in the Botanic Register for March, 1828.

The aërides cornutum is another of these extraordinary ‘ air plants.’ Our figure is copied from Edward’s Botanical Register, though a miniature representation. This



plant appears to have been obtained, in the first instance, from Dacca, by Dr. Roxburgh, and subsequently by Dr. Wallich from Noakote, where it grows on trees and flowers in June. It is cultivated successfully in the botanic garden at Calcutta; and has obtained the name of the 'Jamaica Pomatum Plant,' from the fragrance of its flowers, which some have compared to the tuberose. It has been pronounced the most interesting of its tribe, whether we consider the great mass of its blossoms, their curious form, delicate colour, long duration, or delicious perfume. It flourishes in a damp hothouse, planted in moss, in a pot suspended from the rafters.

The extremes of temperature, under which vegetation is sometimes met with, is not the least remarkable part of the physiology of plants. Decandole discovered snow-drops in full blossom on Mount Saleve, beneath a cerement of ice; and Captain Parry found several plants in full foliage, and about to bloom, hermetically sealed up, under similar circumstances, in the Arctic regions. At the glacier of Roccosecco, one of the branches of the Berneria, in Switzerland, we find a valley full of ice, which the avalanches have from time to time sprinkled with earth. This very thin coverlet of earth, incumbent on a mountainous mass of ice, supports a variety of Alpine plants, and forms a pasture for the herds and flocks of the inhabitants of Samaden. Kotzebue discovered also a carpet of vegetation on an iceberg near Behring's Straits. We found the verge of the Mer de Glace fringed with the rhododendron ferrugineum, and the soldonella alpina, both in bloom; but the

'*Jardin*,' some thousand feet above its elevated level, is one of the most extraordinary features in the history of vegetation. Above the glaciers of Talefre, and the line of perpetual congelation, we meet with this pretty oasis among the snows of centuries, and the glaciers of ages—a garden in a sea of ice. Its interesting flora consists of juncus jacquinii, silene acaulis, gentiana nivalis, achillea nana, cardamine alpina, trefolium alpinum, lichen nivalis, pedicularis rostrata, senecio incanus, and geranium nodosum. Even germination sometimes takes place at very low temperatures. In a New York periodical is the following remark: 'We have seen an ear of wheat enclosed in a solid cake of ice, taken from the centre of an ice-house, the grains of which had sprouted, and the young roots extended themselves nearly an inch into the ice. The ice before put into the ice-house was pounded fine.'

The high temperature sometimes sustained by vegetation has been glanced at, and is equally remarkable. Dr. Schouw informed me that he met with an alga and a hypnum, in the crater of Ætna, in a sulphury vapour, with a temperature of 98° F., so that the source of volcanic fires can boast of a flora of its own. Indeed we have in some cases been surprised at the rapidity with which volcanic ashes are robed in vegetation; as if the genius that presided over her beautiful domain was anxious to veil the devastation occasioned by the erupted ashes with her rainbow mantle. The crimson snow, and the phenomenon of the oscillatoria, will be adverted to in the sequel. Sonerat discovered in the island of Lucania a rivulet, the water of which indicated a temperature of 174°, and swallows flying over it at the height of seven feet, dropt down motionless; yet even here, on its banks, were found two species of aspalathus, and the vitex agnus castus, with their roots dipping into the stream. In the island of Tanna, Messrs. Foster found the ground, near a volcano, 210° F., yet carpeted with flowers. In the canton of the Vallais, and the baths of the Loeche, particularly the thermal one, called Hielbad, in a temperature of 120° F. the conferva clothes the bed of the spring, also its verge; and the larva of the musca chameleon lives there. The ulva thermalis is found in the thermal waters of Gastein, which have a temperature of 117° F., together with a fresh water shell, the limneus pereger. (Drap.) James, in his expedition to the rocky mountains, mentions that a considerable number of thermal springs occur near the base of the Ozark mountains in North America, altogether amounting to nearly seventy, and are found in a ravine. James gives the temperature of some of these springs at 92, 104, and as high as 160° F. Major Long states a number of them at from 92 to 151° F. and adds, 'not only confervæ and other vegetables grow in, and about the hottest springs, but great numbers of little insects are seen constantly sporting about the bottom and sides.' At the thermal waters of San Fillipo, near Acquapendente, confervæ flourish in a temperature of 122° F. In the Lago di Solfo, near Rome, in a temperature of 80°, plants vegetate above, while their lower extremities are entombed in stone. In the silicious deposites, in the Geysers of Iceland, are reeds and rushes, in every stage from their vegetating state until they are finally silicified, while the beautiful mocha stones, or moss agates, shew clearly that the plants must have been entombed alive. In the hot springs of the Azores, as at Furnas, where the temperature varies from 73 to 207° F. are similar phenomena of mineralized grasses, &c., in which vegetation seems as it were to have been taken by surprise, and shut up in a mineral cerement.

CHAPTER X.

Aquatic Vegetation—Purification of the Atmosphere—Eccentricities in Vegetation.

THE necessity of water to the vegetable tribes is sufficiently obvious; indeed some plants will root in water, and remain permanent in many instances. A cannacorus, which had been reared in a pot, was removed; its roots washed, and then transferred to a vessel of water; here it flowered very well. We were also informed of a still more extraordinary phenomenon. The stem with its crown, of a fruiting pine, having been accidentally broken off, was placed in water, and plunged into the bark pit, and we were assured, it not only fruited, but actually ripened that fruit. We purpose in this place however merely to advert to some of the more remarkable phenomena in aquatic vegetation, in addition to what has been previously noticed. Among the most illustrious in this relation, is the water lily, and its magnificent congeners, villarsia, and the rose lily, or Egyptian bean; or the sacred lotus of India. The water lily is described by Linneus, as closing its flowers and contracting its stem towards night; so that the flower cup is in contact with the water. To the same purpose, is the observation of Sir James E. Smith; a singular phenomenon, somewhat however rudely questioned. I have narrowly watched the white water lily, not only during the evening, but a great part of a moonlight night, and my own personal observation tends to corroborate the fact mentioned by Linneus, and repeated by Smith. The phenomenon will mainly depend on the recent evolution of the flower bud, and the circumstances of radiation, &c.; for flowers lose very materially their susceptibility to the action of light, when in an advanced stage of their maturity. Under favourable circumstances, the petals of the nymphæa alba gradually approach toward the centre, as the evening draws on, and sometimes not only is the cup incumbent on the water, but is half immersed; a beautiful provision, enabling the flower to sustain the loss of temperature it suffers from radiation, by the supply it acquires from the water, a medium of comparatively uniform temperature. Here therefore is a truly admirable compensation. Thus the water lily retires to rest in its native element, and rises from its aquatic bed, when awakened by the sun. Then aroused, it lifts its head again, and with its beautiful flower, some inches above the bosom of the water, unfolds its inflorescence in the sunbeam. The lotus of India is allied to the nymphæa. It is found figured among Egyptian hieroglyphics, and crowns the pillars of the temples of Egypt: it is also seen on the ancient coins of Rhodes. It mantles the pools and canals with its floating foliage, relieved here and there by its flowery chalice of a chaste and delicate white, or azure blue. Both of these varieties appear to have been known to the ancients: it is worthy of observation, however, that the rose lily, or sacred bean, so frequently met with among the symbols of that country, has disappeared from the pools and rivers of Egypt: it is however found in India. The figure is that of the lotus of India, or cyamus nelumbo, the nymphæa nelumbo of Linneus. It has a tuberous root, on which the Egyptian lotophagi were accustomed to live. The lotus is found in still pools, and the recesses of streams, in a depth of water varying from two to six feet. It is viviparous, as has been already stated; the capsule, when mature, separating from the plant, and scattering its viviparous offspring on the surface of the water. This beautiful plant is intimately connected with the mythology and poetry of India, and is perhaps that referred to by Homer and Virgil. The diospyros lotus is the lotus or faba græca of Pliny. The rhamnus lotus is a different plant. Sir James Edward Smith describes a carved horn of a rhinoceros sent from China to Linneus. The whole inverted base of the horn is carved into an elegant leaf of the nelumbo rising from the water, amidst a group of Chinese rocks. It is encompassed with various plants of a more diminutive proportion; a peach tree,

and a medlar, (mangostan?) with sagitaria, pothos, and the nelumbo itself in flower and seed, covering the outer surface. I have the nelumbo painted on the skeleton leaf of the banian. Theophrastus expressly alludes to the lotus sinking beneath the surface of the water at night, and emerging in the morning. ‘The flower is white, consisting of many crowded leaves about as broad as those of the lily. These leaves at sunset fold themselves together, covering the seed vessel: at sunrise they expand, and rise above the water. This they continue to do till the head is perfected, and the flowers fall off.’ ‘It is reported that in the Euphrates the head and flowers keep sinking till midnight, when they are so deep in the water, as to be out of the reach of the hand, but towards morning they return, and still more as the day advances. At sunrise they are already above the surface with the flower expanded; afterwards they rise high above the water.’ Pliny and Prosper Alpinus give their testimony to the same belief, and the latter observes, that “the celebrated stories of the lotus turning to the sun, closing its flowers, sinking under water at night, and rising again in the morning, are conformable to what every body has observed in the nymphæa.”* In the seeds of the nymphæa nelumbo the infant plant is distinctly seen, so much so, that Ferber was enabled to ascertain the name of the plant to which the seed belonged.

Equally celebrated in its physiology is that remarkable aquatic plant, the vallisneria spiralis. It is found in the East Indies, Norway, various parts of Italy, and abundantly in the Rhone. Dr. Schouw informed me he discovered what he regarded to be a *new species* in the fosse round the walls of Milan. It is also found in the vicinity of Pisa, where we have seen it. Its physiology is singularly curious. The plant is diecious. The subjoined figure represents both plants; that on the right bears and perfects the seeds. The flowers that bear stamina forming the left hand figure, are produced at the bottom of the water, till they come to maturity, but without unfolding their blossoms, they then *separate* from their foot-stalks, and rise like little bubbles to the surface, where the flower expands in the air, with an elastic force, and floats at large on the surface of the water. The other plant, quite distinct, bears the flower on a *spiral* stem, which at the same season, has the property of uncoiling and raising the flower on its summit, according to the depth of the water. The spiral stems

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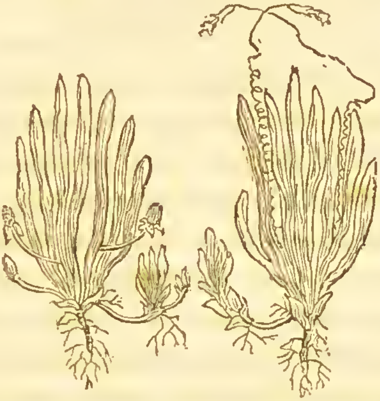
* Smith's Introduction, London 1814, p. 251.



thus wind up their flowers to the surface, ascending at the same time with the other, and receive the pollen from the floating flowers. The flowering season being past, the spiral stem contracts, and withdraws its seed vessels to the bottom, to be there perfected. This consentaneous evolution of flower, on distinct roots, is one of those extraordinary facts which can be no further analyzed :—like the stork in the heavens,

'It knows its appointed time.'

There are few phenomena among the wonders of vegetation more remarkable than those connected with the mechanism of the vallisneria spiralis. The flowers of the one plant having but a temporary purpose to fulfil, separate at once from the parent stem, rise to the surface, and float about in remarkable abundance: the flowers of the other remain still attached to the plant, because they have to perfect their seeds, and that too beneath the surface of water, as the autumnal crocus does below the surface of the earth. The spiral coil is beautifully adapted for this purpose, as well as to raise the flower which crowns it, to the surface in the first instance. As the level of the water is never uniform, but rises and falls, as is the case in the Rhone, where the plant is found; from the irregular source of the debacle, which supplies it; so the spiral coil can accommodate itself to the variable depth.

The calitriche aquatica, or water star grass, is common in our ditches; it blossoms from April to October. Until the period of inflorescence, the entire plant floats on the water, like the lemna: as soon as this is completed, the plant sinks, takes root in the subaqueous soil, and there matures its seeds. These seeds germinating in their turn, the young plants rise to the surface, there flower, and sink, like their parent, to perfect their seeds.

The lesser bladder-snout, lycopus europeus, is another of these aquatic wonders. Small bladders near the root are supplied with a lid, opening outwards. In the first instance, these vesicles are filled with water, but this is afterwards exchanged for air toward the period of their inflorescence, by which means the stems become erect, from a decreased specific gravity, the flowers thus raised to the surface, blossom in the air; and as soon as the period of inflorescence is completed, the bladders again exchange their aërial contents for water, by which means the stems sink to the bottom, and the seeds are there matured.

Not the least interesting and curious question, connected with vegetation, is the relation it sustains to the atmosphere; which is common to both animal and vegetable nature. The amount of the deterioration of the atmosphere by animal respiration is very considerable, and this deteriorating process is continued without intermission, night and day. A certain per centage of its oxygene is supplanted by carbonic acid gas, and we have every reason to believe that the salubrity of the atmosphere is constantly assailed by animal respiration, under whatever form it exists: even by insect life and the tenants of the deep; for the latter rise to the surface to breathe. When we consider the immense superficies of vegetation, if it can be proved that the organs of plants, like those of animals, inhale air and expire a gaseous product, it follows that its influence on the atmosphere must be very considerable. It seems very clearly ascertained that the green foliage of plants, when acted on by solar light, evolves oxygene; an aërial principle formerly called vital air. It may with great propriety be still termed the stimulating or vital principle of the atmosphere, the too active powers of which are beneficently modified or subdued by its intermixture with nitrogene; which last amounts to seventy-nine per cent. The flower, and such leaves as are *not green,* rather deteriorate the atmosphere than otherwise. They need not however be taken into the account, as their comparative amount is but fractional, so their influence is scarce appreciable. Ingenhouz discovered that light was an essential condition to the elaboration of oxygene, by green leaves; and that carbonic acid gas, on the other hand, was evolved in darkness, and during night. Sennebier discovered that the quantity of oxygene had a determinate ratio to the thickness of the parenchyma.

Among those opposed to the views we sustain, is Mr. Daniel Ellis, of Edinburgh, but after an attentive consideration of all that he has brought forward, we can observe no tangible data on which dissent can be sustained. Both experiments and phenomena seem equivocal and inconclusive. Aquatic plants, which hold a most important relation, appear to have been almost entirely overlooked. Now these are especially concerned: the water lilies, water crowfoot, water star grass, pondweed, duckmeat, and others, operate very beneficially, and the sparkling air bells, which escape from the surface of water where these are growing in the sunshine, and seem so incessant and so abundant, prove their importance.—Even the rudimental matière verte is not idle; the crowsilks are most active in their elaborations; indeed the conferva bullosa is preserved buoyant by vesicles supplied with oxygene. In consequence of this, fish always thrive best where there is an aquatic vegetation. They are much less healthy where the pond is denuded of water plants. These well accredited facts attest to demonstration, that aquatic vegetation sustains the salubrity of the air mingled with the water, and it is indubitable that fishes and other aquatic animals do deteriorate that air. This being the case, it follows that terrestrial vegetation must be equally influential in the support of an oxygenated salubrity for the sustenance of animal life.

Sennebier ascertained that plants watered with carbonic acid gas respired an extraordinary quantity of oxygene. Ingenhouz also found that elastic oxygene was emitted from leaves immersed in water, by their inferior surface. He placed a vine leaf in an ounce phial of carbonic acid gas, in the sunbeam, without water, and it was discovered to have been changed to pure oxygene in an hour and a half. The late Colonel Mark Wilks informed me he had universally found in Indian climes that the land breezes wafted over the surface of vegetation was four per cent purer than the sea breeze. Sir Humphry Davy, and other experimenters, have always discovered that imprisoned air was purified by growing vegetation, when watered with carbonic acid gas. I put a tuft of cress, growing on a portion of sponge, into a glass cylinder, supplied with a small portion of distilled water, and the vessel was completely filled up with pure carbonic acid gas; after the lapse of several days and nights, the aërial medium was discovered to be remarkably pure. We are warranted to conclude, therefore, that vegetation acts a most important part in sustaining the salubrity of the atmosphere. Gay Lussac ascertained that the air in water, under such circumstances, contained 32 per cent. of oxygene, while our atmosphere contains only 21. It is an ascertained fact, that carbonic acid gas enters the vegetable system by the roots, and equally certain that the foliage absorbs it by day. But while it is freely granted that carbonic acid gas is evolved during night, it must be obvious, that this is of necessity a mere comparative fraction; because as carbon constitutes the greater part of the vegetable structure, it must be assimilated; and being so, must be decomposed, to the liberation of oxygene. In winter, when we have our shortest days and longest nights, vegetation slumbers, and cannot materially affect the atmosphere. When the medium is cold, the carbonic acid gas will fall to the ground, from its great specific gravity. On the other hand, when vegetation unfurls its mantle, the nights are reduced to their minimum duration. The sun beams are powerful, and the day is prolonged to its maximum. When we consider the incomparably greater extent of vegetating surface, compared with that occupied by animal life, we infer that its salubrious influence must be very considerable. There is another circumstance, which ought not to be overlooked, the carbonic acid gas, which evolves from the leaves of plants at night, will not rise into the atmosphere ; it will be condensed by the dews, and either trickle to the ground, where it is absorbed, or be decomposed in the morning sunbeams, by the chemical action of the leaf conjoined with that of light. It is a well ascertained fact, that dew, collected from the leaves of plants, contains a great quantity of carbonic acid gas. Lampadius found two per cent. of carbonic acid gas in that collected from the foliage of alchemilla vulgaris.

We have stated that carbonic acid gas is of great specific gravity. If atmospheric air be numerically represented by 1000, this gas will be 1523,6. Indeed it tumbles to the ground unless expanded and sustained in its buoyancy by heat. The carbonic acid gas, therefore, which is respired at night, whether from an animal or vegetable source, will not materially deteriorate the atmosphere; but it must not be forgotten, that animals by *day* as well as by night are incessant in the destruction of the salubrious principle of our common atmosphere. From the causes assigned, the counterforte is chiefly, if not exclusively, required during day, and it is precisely at this period, that vegetation sustains the important function of restoring to the atmosphere the lost balance of salubrity. Again, when our forests are denuded of their foliage, in the winter of the year, the breeze of health, animated by the oxygene poured out into the atmosphere, in southern and tropical climes, will be wafted in winter to our zone. The picture of the creation of vegetation, as drawn by the sacred historian, is not only full of majesty and beauty, but singularly corroborates these interesting deductions. " And the earth brought forth grass, and herb yielding seed after his kind, and the tree yielding fruit whose seed was in itself after his kind, and God saw that it was very good." Vegetation had spread its verdant mantle over the scene of creation on the *third* day of the hexaëmeron; and the sunbeam had already played on its foliage, before other animated forms had assumed their several stations in this magnificent and beautiful world. The counterpoison was prepared before the poison itself had been elaborated. No doubt then remains that vegetation is the grand *oxygenemetron* of the atmosphere, and its salubrity is maintained inviolate by it. The animal and vegetable kingdoms thus display a beautiful and beneficent reciprocity. Neither the one nor the other can say to his fellow—" I have no need of thee." The plant then purifies what the animal poisons; and intelligence signifies its willing amen to the sentiment of Franklin, on its announcement by Priestley, ' it is of a piece with the rest.'

Plants are often truly eccentric in their habitats, and the conditions under which they are found. There are few localities or circumstances into which vegetation does not obtrude in some shape or other. The island of Ormus, in the Persian Gulf, is indeed said to be void of vegetation. It is one mass of rock salt; still the humbler forms of vegetation, in many of the lowly lichens or aërial flags, may be overlooked by the common observer. Even in the subterranean excavations of the mine, plants have been discovered; and Humboldt found a *green* plant in one of the mines of Freyberg. In caverns and caves many fungi take up their abode. In a black marble quarry at Ashford, in Derbyshire, according to Mr. White Watson, the roof was supported by an oak post in 1773, and in four years after its surface was mantled with the mouse-skin byssus, byssus septica; the agaricus campestris, and boletus tenrex also grew out of the post. It is the mouse-skin byssus, called also mouse-skin rag leather, racodium cellare, which is so very common in wine vaults or cellars, covering the roof, or investing the posts, casks and wine bottles: it is said to be more rarely found where empty bottles are stored; damp, and perhaps vinous vapour may be therefore necessary. The byssinæ occupy many singular and extraordinary situations: sometimes they are found to clothe damp walls with a verdant tapestry, or discovered on the exterior surface of the damp flower pot. The thread-like lanosæ and hyphæ float about, more aërial than fixed. We find these curious plants under very singular circumstances, and in media where we should scarce expect vegetation to exist. Dr. Fleeming found a cryptogamus plant, likely one of the byssinæ, perhaps a hygrocrocis, as this class is now termed, in the succinate of ammonia. They are found in *molasses,* in *ink, rose water, solution of issinglass,* &c.; hence the names hyg. rosæ, atramenti, &c. I discovered a hygrocrocis in nitrate of baryta, hydriodate of potassa, and what was still more extraordinary, in the *arseniate of potassa!* We know that some of the fuci, or sea weeds, will vegetate on the copper sheathing of ships; the byssocladium fenestrale will grow on glass, and the biatora decipiens will vegetate on iron.—Mushrooms grow up in curious places. Decandole found a group of mushrooms which had germinated among old rags. On the 5th July, 1832, a mushroom was discovered to have sprung up from one end of a tobacco box, at Caistor; the stem was about the thickness of an ordinary quill, it was 2½ inches long, and the head was 1½ inch diameter: another one was found in the same place, in embryo. The ruins of the Colliseum at Rome, have afforded a rich harvest for the botanist, several hundreds of species of plants having been discovered among its mouldering walls; but few would have sought for a plant, above the dome of St. Paul's cathedral, yet Mr. Sowerby found there the trichia polymorpha, on a cindery substance. Dr. Butler, of Shrewsbury, shewed me a phial of water, taken from a well called 'Fynnon ocr,' near the summit of Snowdon. It contained one of the byssi, which had developed only a faint tinge of green. He informs me it was taken from the well in 1808, during a thunder-storm, accompanied with rain, and was corked at the time; ever since it has remained in a dark closet, and about ten years ago this confervoid production began to form. As connected with this growth in comparative darkness, I may now mention a singular fact connected with the growth of thistles in complete darkness. In 1816, the Rev. Mr.

Lloyd, of Whittington, sunk a ditch in order to convey water from the castle grounds, to supply a bath near the parsonage: the fall for the water was about eighteen inches; the extent to which the water was conveyed was about five hundred yards. The pipes were of earthenware, each about a foot long and 3½ inches in diameter, these were conjoined with plastic clay. The water continued to run for about a year, and then nearly ceased. When the pipes were taken up, they were found full of *thistles,* many of which were several feet long. These were removed, but were soon substituted by others. The depth of the pipes varied from eighteen inches to six feet, but this made no difference in the growth of the thistles. In no part of its course was the water exposed either to light or air. The pipes were quite full of water, and thistles were found growing throughout their entire extent. I have extracted the preceding detail from Mr. Lloyd's communication to me.

I observed that the water wheels which are supplied from the celebrated spring of Holywell, in Flintshire, were completely invested with a beautiful mantle of crow silk, so that the wood is entirely concealed. At the bottom of the well, the water of which is remarkably pure, being almost insensible to chemical re-agents, the stones are spotted red with the lichen jolithus, which the legends of superstition attribute to the blood of St. Winifrede.

We have already alluded to some of the lichens or aërial flags; a most interesting class of epiphytes, and called in terms sufficiently poetical and descriptive, 'time stains.' The lichen geometrica imparts to the surface of the rock a very beautiful character. Some of the rocks around the 'Lac des quatre Cantons,' in Switzerland, cannot, in this respect, be sufficiently admired. The lichen lactea imparts to the rocks it overspreads the appearance of their having been whitewashed. The 'lichen grey' is sufficiently expressive of these 'time stains;' and often imparts an emphatic though silent symbol to the antiquated mansion, or the mouldering ruin. Graphic lichens inscribe in curious hieroglyphics, yet intelligible characters, on various barks, their worth and worthlessness. Some of these epiphytes are discovered on *particular* officinal barks, and not on others; enabling us thus to distinguish them; while peculiar lichens make their appearance, as soon as these officinal barks have lost their value; and thus stamp, as it were, the 'broad arrow' of condemnation on them. These symbols of creation, therefore, when rightly interpreted, by the skill of the cryptogamist, become a valuable key to practically useful knowledge. In a former chapter we incidentally adverted to what superstition has termed gouttes of blood, as preternatural indications of offended DEITY; these spells and enchantments, however, have been broken by the investigations of science. Such appearances have been approached, examined, and referred to natural causes. 'Gory dew,' palmella cruenta, contracts in dry weather and disappears; and when moistened with dew, or after rain, spreads out anew its ensanguined mantle on the plain, while superstition shudders as it passes the ominous spot. The palmella cruenta is found in many places; 'it forms,' says Dr. Johnstone, 'broad indeterminate patches of a deep rich purple, with a shining surface, as if blood or red wine had been poured over the stone or ground;' of a similar character is 'bloody rain', as well as that which is found sometimes to dye the pools with gore. Humboldt mentions *red hail;* and not only has 'crimson snow' been repeatedly seen, but both 'snow and ice were observed to be stained red, green, and blue, by the late expedition under Baron Wrangel, to the frozen ocean.' The 'crimson snow' is well ascertained to be the protococcos nivalis; and as Mr. Burnett observes, *blue* might be imparted by byssus cobaltiginea, *green* by palmella botryoides, and *yellow* by lepra candelaris, or chlorina. We think it by no means improbable that vegetable being may continue to float in the air, germinate, and live there, from whence it may be precipitated, by meteoric changes. It is true that the 'bloody rain' lepraria kermesina, is found beneath stones, and in the cavities of rocks, but it is not so clear that it is a modification or particular stage of the 'crimson snow' plant; and with the natural history of the nostocs, 'fallen stars,' 'dead will-o-the wisps,' 'flowers of heaven,' (nostoc cœruleum,) we are still too imperfectly acquainted, to form an accurate judgment. The occasional luminous character of the latter is not the least curious feature connected with them. I must confess that these phenomena present to my mind a difficult problem, if we deny an aërial origin to 'crimson,' and other coloured snows. We know that there have been peculiar atmospherical precipitations from time to time, placed on authentic record. In the years 1824 and 1828 a nutritious substance, of a vegetable nature, proved to belong to the aërial flags, fell in Persia, and in some places to the depth of five or six inches. Peculiar visitations, connected with atmospheric precipitations, have been well attested in various countries, as Germany, Bohemia, and elsewhere, which leave no doubt as to their meteoric origin.

The 'crimson snow,' it will be remembered, was brought into particular notice in the Arctic expedition, under Captain Ross. This very singular mantle, for what is proverbially pure and white, could not fail to excite attention: on accurate examination it was found to be a plant, the protococcus nivalis of Agardh, and the uredo nivalis of Bauer. It must be observed, however, that this extraordinary plant cannot be exclusively claimed by these regions. It has since been likewise found in the Antarctic Regions, in 'New South Shetland.' It occurs too on calcareons rocks in Scotland, in the Isle of Lismore; and has been found among the Alps, and elsewhere in Europe. As far back indeed as 1760, the indefatigable Saussure found it on Mount Breven, in Switzerland, and it subsequently occurred so frequently, that he considered it a matter of surprise that it had so long escaped the notice of travellers. Ramond found red snow among the Pyrenees; and Somerfeldt, on the mountains of Norway. In 1818 a considerable extent of red snow covered the Appenines, and Italian Alps; even the Great St. Bernard has put on here and there this crimson veil. About 1808, the snows around Belluno and Feltri were tinged red by this plant to a considerable depth. Captain Ross estimates the Arctic mountains, on which the red snow was found, at six hundred feet high, and eight miles long. The depth to which this red tinge has been observed is variously stated; from two inches to several feet. Animalculæ have been found in snow, however fabulous we may deem the 'snow-worm' of Persia, one of which is stated to cool down a bowl of sherbet. Here too we have an extraordinary plant maintaining its vitality amid the eternal snows of the highest latitudes, and the loftiest elevations, which have ever been scaled by the daring enterprise of man; and, as has been observed, 'presents to the astonished and admiring navigator, a sight more surprising in its reality than any of the fabled wonders of an Arabian tale.'

Even the lowliest of vegetable forms possesses a beauty and an interest peculiarly its own; and some may, if attentively considered, prevent, if not serious accidents, at least superstitious fears. The 'mouldiness' and 'mildew' on cheese, bread, and fruit, are attributable to minute parasitic vegetations, which the application of the lens will speedily determine. Mouldy bread has been productive of serious illness; and the violet spots in rye bread, we have already mentioned, as due to the secale cornutum. Bread owes its mouldiness to a plant called mucor mucedo. A curious circumstance occurred in Padua, in August, 1819; the alimentary substance, called by the Italians *polenta,* is a compound of maize-flour, salt, and water. It was prepared in a family in the usual way, but was discovered to be full of red spots; this was cast away, but the red spots appeared in the next preparation, which excited consternation and alarm. The blessing of the priest was implored, and given; still it was of no avail; prayers, fasts, and masses were equally ineffectual. The gouttes of blood still appeared! The neighbours regarded the house and its inmates with fear and horror; in their opinion it must have been the produce of some old corn, refused to the poor during the famine of 1817; and this was an evidence of the divine displeasure. A skilful botanist however restored tranquillity and peace, by tracing the cause of alarm to a cryptogamic vegetation.

CHAPTER XI.

Relations of Light to Vegetation——Changeable Flowers——Nocturnal Inflorescence——Night Smelling Plants——Peculiar Structure in Vegetation.

That light is a most important agent in vegetation there can be no doubt whatever. Facts have been alluded to, in reference to leaves, which leave no doubt on the subject. By admitting light, through different coloured lenses, the plant is pale as it approaches the violet. Sennebier had observed, however, that crocus and tulip flowers are coloured in the dark; but these may be considered peculiar provisions. When at Rome, in 1819, we understood that the professor of botany in that city, had made a great many experiments on coloured light in respect to vegetation, and found violet light most efficient. In America, clouds and rain often obscure the sky for many days: during these periods the leaves of entire forests evolve, and until the sun re-appears, are pale: in a few short hours after the sun breaks forth, their vesture is a beautiful green. We find a curious statement of this kind in Professor Silliman's American Journal: a forest is there mentioned, on which the sun had not shone for twenty days. In the meantime, however, the leaves had expanded to their full size, but were almost white. The following remarks describe the effects of the sunshine. "The colour of the forest absolutely changed so fast that we could perceive its progress. By the middle of the afternoon the whole of these extensive forests, many miles in length, presented their usual summer dress."

Plants on elevated regions, when their flowers are blue, assume deeper and purer tints, than on the plains. The gentiana, soldanella, and others, are

> "Darkly, deeply, beautifully blue."

And if our views are correct, scarlets and crimsons will be more intense in tropical, than in temperate climes; yellows, more pure, and less dilute and turbid, in temperate than tropical regions; and blues more deep in higher latitudes. The effects of light on the flower, we have observed to be remarkably striking in the daisy. This flower opens rapidly on the sunny side of a road, and shuts as promptly on the obscuration of a passing cloud, or the advent of rain; while on the other side of the same road, the daisy does not shut so rapidly, in the periodical intervals of shade. In the kaulfussia amelloides, the flower rolls back the extremities of its petals in gloomy weather, and at night; a remarkable phenomenon, contrary to the usual phenomena manifested under such circumstances, by the corolla of the flower;—so partial is our knowledge of the mysteries of creation.

Even artificial light will frequently affect the flower: that of the crocus, placed between two candles, after being closed; at a temperature of 70° to 75°, was fully expanded in an hour. The daisy, however, has been ever observed to manifest a remarkable obedience to the influence of light. This pretty flower, associated with our earliest recollections, was so called, as being emblematic of 'the eye of day,' from opening its petals to the rising sun. Chaucer thus notices the daisy.

> " The Daisie, or else the eye of the Daie
> ——— She that is of all flowris the floure,
> * * *
> To seene the floure how it will go to rest
> For fear of Night.———"

The French call the daisy, *La belle Margarete.*

The scarlet pimpernel, anagallis arvensis, is so susceptible of atmospheric changes, that it has been called 'the shepherd's weather glass;' it closes its flower almost invariably before rain, though thunder storms sometimes take it by surprise.

Among the more remarkable phenomena of flowers, is the mutability of their colours. Thus the rose unique, and rosa odora, change their hues gradually; the latter is white in autumn, pale blush in April, and red in June and July. The changeable crysanthemum, already noticed, is another example. The polemonium cœruleum changes its flowers from blue to white. The vermilion leafed castilleja is a pretty, hardy annual, found by Mr. Douglas in abundance in upland meadows about the river Columbia. The vermilion colour of the bracteæ, sometimes varies to a lively yellow, and even to white. The androsace villosa is very remarkable for its change of tint. The central star in the flower, at first green, becomes subsequently yellow and finally flesh-coloured. The leaves of the geranium lucidum become redder and redder every day. The changes in autumn are very striking. The geranium robertianum becomes in autumn, a vivid crimson. It must have been noticed that many of the yellow petals of the ranunculus acris in our meadows, change to white as the flower advances to maturity; this is also the case with the marygold and some other yellow flowers: I also find that the yellow blotches on the aucuba japonica, become pale, and even white, as the leaf advances in growth.

To the preceding examples we may add a few more striking instances. We have already adverted to the change of leaves in autumn; the fact of the acid change in the ascidium of the nepenthes, enables us to solve the problem of these mutations, which are sometimes very striking; the foliage changing to red, yellow, white, and even blue; for instance, the vine, shumack, azalea pontica, cornel, scarlet leafed oak, and others. The leaves of the guelder rose and way-faring-tree, assume a deep red tint in autumn. Chemical changes are going on in the leaf by the electro-chemical action of the solar rays, and perhaps when the tree ceases to absorb cambium from the leaves, this proper juice, by remaining in the leaves, and being thus subjected to a much longer continued action of solar light, superinduces that series of autumnal changes, which announce the gradual decay and final fall of the leaf.

The same explanation applies to changeable flowers.

In the 'forget-me-not,' the flower buds are of a most delicate rose colour, which become of a bright blue when they open. The flowers of the pulmonaria when they expand are pink, but subsequently change to blue. The hydrangea also exhibits a change of colour. Yellow flowers we have mentioned, become white; and red and blue flowers sometimes also change to white. The prickley comfrey, symphytum asperrimum, a native of the Caucasus, changes from red to blue. Sometimes, as in the case of the japan honey-suckle, there are various coloured flowers on the same plant. The rosa multiflora, (var. Grevellii,) displays roses of various tints or shades at the same time. But in the lonicera japonica, the flowers, when they expand, are a pure white, which change to bright yellow; and as there must be on the same plant, at the same time, flowers of different maturity, the natives call them 'gold and silver flowers.' The gladiolus versicolor is the most rapid in its changes; quite a chameleon flower. It passes through a complete series of changes of colour, from morning to night, repeating the series the following day. Mr. Andrews mentions that an artist had begun a drawing of the plant about ten o'clock, but the flower was so totally changed before the drawing was completed, that he was under the necessity to wait until the following day, to finish it. The changeable rose hibiscus, hibiscus mutabilis, a native of the east, is equally extraordinary. The flower when it unfolds in the morning is green, it then changes to white, about noon it is of a reddish or carnation hue, and in the evening a rose colour or bright crimson. That temperature is connected with these changes, there can be no doubt. We have already adverted to our experiments on the temperature of the flower on its evolution, and of the different colours which invest flowers. M. Ramond de la Sagra, of the botanic garden of Havanna, observed on the 19th October, 1828, that this singular flower remained *white* all day, and did not begin to redden till the following day at noon. It appears that on the day in question, the thermometer did not rise above 65.5 F., though the usual temperature was more than 86° F.: the correspondence of these changes with the rise and fall of temperature, in the surrounding atmosphere; attest clearly the operation of chemical changes, which would be more or less affected by mutations of temperature. Mr. Brande says, " I observed in 1802, on completing the voltaic circle by means of the petal of a flower perfectly white, that the part of the petal communicating with the end of the electric series became *red;* while that communicating with the other end became *green.*" This interesting experiment seems more intimately to connect, in its solution, the changes in autumn, and the phenomena of changeable flowers, with electro-chemical action, than any other that I am acquainted with.

Particular flowers are remarkable for opening and shutting at specific periods of the day. Some unfold the blossom early, and shut late in the afternoon; thus noticed by Shakespeare;

> 'The marygold that goes to bed wi' the sun,
> And with him rises weeping.'

The dandelion opens at 5 or 6 A.M., and shuts at 9 P.M.; the mousear hawkweed opens at 8 A.M., and closes at 12. The sow-thistle at 5 A.M., and closes between 11 and 12. The goats-beard at 3 A.M., and closes about 5 or 6 P.M. The forked marvel of Peru, is called at the Cape of Good Hope, the 'four o'clock flower,' because it closes at that hour. The white water lily opens at 7 A.M., and closes at five in the evening. The scarlet pimpernel opens at 7 A.M., and shuts at 8 P.M., except on the approach of rain. The drosera is equally precise in opening and shutting its flower. If the ensuing day is to be fine, the Siberian sow-thistle shuts at night; if, on the contrary, the evening indicates clouds or rain, it remains open. Certainly the most remarkable phenomenon in the evolution of the blossom is *nocturnal* inflorescence. The night flowering cereus has already been mentioned. The mysembranthemum noctiflorum, as its name imports, is also nocturnal. A kind of trichozanthes, attains in India the summit of the highest trees, producing a beautiful white flower with a fringed edge; it expands however at night, and is consequently rarely seen. It seems probable, from the experiment already referred to, of a hot iron causing the immediate expansion of the cactus grandiflorus, when about to bloom, as well as the other experiments, I have recorded on the increased temperature of flowers on the eve of, and during expansion, that there is a sudden increase of temperature in nocturnal flowers, which forms an ample substitute for the absence of light, for as soon as the sunbeams smite them, they decay.

Next to these, are night smelling flowers. Perhaps all flowers are more fragrant at night and in the morning, from the increased elasticity in the atmosphere, occasioned by moisture; because the dispersion of the aroma of the flower, would thus be more amply secured. The fragrance of the wood bine, and eglantine, are far sweeter in the morning and evening; and Kalm mentions this especially in reference to the flowers of the magnolia, which are particularly delightful in the evening. When the wild cape jessamine is in full bloom, the fragrance is wafted to a distance of many miles. Thus it is too with

'—— The spicy shore
Of Araby the blest.'

There are particular plants which are altogether without scent during day, but emit their perfume in the evening. That class of flowers, which Linneus, with so much characteristic elegance, denominated 'flores tristes.' Among these may be mentioned cheiranthus tristis, pelargonium fillipendulifolium, pelargonium gibbosum, linnea borealis, pelargonium triste, daphne pontica, and numerous others. As ammoniacal gas seems to increase the aroma of perfumes, according to M. Robiquet's experiments, and even to restore or develope fragrance where it has been apparently lost; it is not improbable but some ammoniacal evolution may accompany nocturnal inflorescence. Certain it is, that nitrous acid gas is developed in the maceration of the hyosciamus; and one of the principles of ammonia is nitrogene, the base of nitrous acid gas.

M. Chevalier, however, ascertained that ammonia was disengaged spontaneously, in a free state, from the chenopodium vulvaria, during vegetation; and he and M. Boullay have determined that a great variety of flowers, even those that are fragrant, give out free ammonia during vegetation.

The physiognomy of plants imparts to the varied landscape an interminable diversity of features. In the kingdom of vegetation there is no monotony: the sublime and beautiful of the picturesque mingle together. Features, otherwise stern and rugged, are softened and chastened down with the mantle and veil of vegetation. The rocky Aiguilles, towering above the clouds, having pierced the snows of centuries, impart indeed feelings of awe; but the eye reposes with more serene satisfaction on the crest of the mountain, when plumed with pines and nodding in the breeze. There is an unearthly majesty in the former, but an imperial grandeur in the latter truly terrestrial. The palm, the cedar of Lebanon, the oriental plane, the oak, the pine, have each a character peculiar to itself, and singularly its own. The agave, cactus, euphorbia, bamboo, inspire another train of diversified feelings . The yew and cypress are mournful and funereal. The casuarina, weeping willow, and the weeping birch, with poetic elegance, not inaptly designated,

'The Lady of the Woods,'

are singularly graceful and beautiful. To describe however the physiognomy of trees and vegetation would require a volume: what would the surface of the ground be, were it unclothed?—Let imagination supply the answer.

Though palms have been considered as crowned with a solitary canopy, there are palms that have several heads; the doum palm of Upper Egypt (hyphæne coriacéa), together with a kind of palm found in Madras, have their stems bifurcate, with each a crown; and some palms in India have as many as six heads. Nor is the difference in altitude among the palms less striking: the phœnix farinifera is a dwarf palm, with a trunk scarcely exceeding two feet in height; while the talipot palm towers sometimes to the altitude of one hundred feet; the spatha, after having burst with a considerable explosion, liberates its spadix, a magnificent stem, adorned with blossoms, and soars to the height of thirty feet above its imperial diadem of leaves. I must however limit my attention more particularly to the odd and antiquated.

The euphorbia antiquorum attains the height of forty feet: its stem is angular, and the angles are curiously scalloped. This vegetable column is fluted, and from its summit ascend succulent and angular branches. At the termination of these branches its golden blossoms are unfolded, and finally succeeded by a triangular deep crimson tinted fruit. Bruce observes that from the abundance of this tree at Taranta, the mountain seemed to be covered with a veil of the most vivid crimson. Waiving, however, the curious forms of the cacti, we may now advert to the mangrove, its peculiarity having already been slightly noticed.

In Bennett and Tyerman's voyages there is described a tree singularly fantastic, and from the description, appears to be a mangrove. It is represented as growing at Huahine, and called by the natives *aoa*: the trunk is composed of an immense number of stems united together, having a singular appearance from the numerous grooves which run vertically up the bole, and are of such a depth that a transverse section would, it is stated, rudely resemble the axle and spokes of a wheel, without the rim. The girth at the foot is seventy feet. From the height of eight to forty feet immense branches proceed in nearly horizontal directions on every hand; from which, as from similar trees, perpendicular shoots bend downward, till they reach the ground, take root, and become columns. Forty of these were enumerated, and a circle, drawn round all their auxiliary stems, was not less than 420 feet. The 'upper stories' are stated to be yet more remarkable, resembling "gothic arches, oriels, and colonnades, propped as by magic in mid-air." The height of this tree was computed at eighty feet. It is situated so near a lagoon, that several of its branches overhang the waters. Humboldt mentions that some of the South American trees, of the genus ficus, put on an appearance as if the tree was supported by buttresses. Sometimes these rooting branches are very elastic, and have a considerable tension. In Surinam there is a tree, the roots of which are so much in relief above ground, that their caverns would conceal more than twenty individuals. Dampier describes the mangrove, by the verge of creeks and the sea side, exhibiting an appearance in consequence of this fantastic growth, as if the tree was supported by artificial stakes. He mentions having walked half a mile, by stepping from root to root, without once setting his foot on the ground. We have already stated that this very extraordinary appearance is produced by the lower branches bending to the earth, and striking root, there being in fact two classes of branches one bearing roots, and another bearing leaves. Mangroves afford protection and support to beaches thrown up by the sea. They become a complete breakwater, and defence to the land. To the leeward there is of necessity a tendency to the formation of land; mangroves therefore are making constant inroads on the boundaries of the ocean, and gaining trophies from the deep. The silt and rubbish accumulate on their roots: the new low land, thus recovered from the ocean, is soon filled up by alluvial matter, washed down from the main land; while the cocoa nut usurps the privileged soil, mingled with papyrus. Sometimes the new land is detached from the mainland by currents, and form matted floating islands, covered with mangroves and papyrus. Professor Smith saw a floating island of this kind, off the coast of Africa, consisting of reeds, resembling the donax, and among them were still growing some branches of justicia. We have already observed that mangrove roots, thus in constant conflict with the sea, and grappling with its waters, are often singularly bedecked with shell fish.

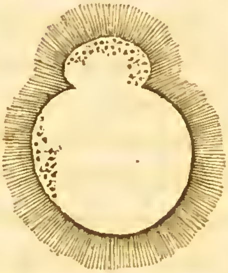
This, it is true, is a remarkable exception to the general character of vegetation, as plants are more frequently found retiring from the sea, and rioting in impenetrable forests inland; but here we see vegetation boldly invading the territories of the deep, and pushing its conquests like a maritime power. We, however, find, though under lowlier aspects, breakwaters and defences constructed by vegetation, not less powerful and efficient against the invasion of the sea upon dry land, though of humbler growth. The very existence of a kingdom depends on sea-reeds, sedges, and kindred plants. These form the defence of the dykes of Holland, and prevent not only the invasion of the sea, but the advance of the drift sand on the fertile soil. When in a solitary walk, by the sea side, we have heard in a still night, the sentinel from the rampart, repeat the watch-word, "All's well," we have turned instinctively to the 'sea-mat weed' on the shore, mantling the beach: the sentinel of Providence, that forbids the approach of the waves, as if commissioned to say to them, 'hitherto and no farther, and here shall your proud waves be stayed;' and have then responded 'All's well.'

There is an interesting incident of recent date connected with the rock samphire, erithmum maritimum, the detail of which may not be out of place here. It should be stated that this plant never grows within the reach of the waves, though it nestles on the sea coast. During a storm, in November, 1821, a vessel was driven on shore near Beachy Head. It appears the entire crew were washed overboard, a few escaped to the rocks, apparently only to await a more lingering death. Each advancing wave narrowed the circumference of the little circle. They had already retreated to the highest point, and while debating whether to cast themselves into the waves, and trust the desperate event, or remain to be swallowed up; one, in his struggles had laid hold of a plant of the crithmum maritimum, which he providentially remembered never *grows beneath the surface of the water.* It was enough. Infinite wisdom had 'cast the lot' for the crithmum maritimum. It was the symbol of safety, and assurance was restored. Thus was the rock samphirelike the olive branch to the patriarch, fraught with the message of Providence, and the import of its language was "All's well."

CHAPTER XII.

Relations of Electricity to Plants—Luminous Plants—Irritability of Plants——Sleep of Plants.

THAT vegetation powerfully modifies atmospherical electricity, and is affected by it, there can be no doubt. In a stormy night, minute stars of electric light have been seen to tip the summits of thorns. In this respect, the experiments of Astier are interesting. An insulated species of the gleditchia triacanthos, was made to terminate a conducting wire to receive and carry atmospheric electricity to an insulated flower pot, in which maize was sown. The subject of insulation gave unequivocal proofs of being electrified, and the seed grew much more quickly than otherwise. In like manner, under similar circumstances, Bengal roses shewed their inflorescence more rapidly, and the flowers were more abundant than in others. Spines, and pinnate, and lanceolate leaves, must therefore be powerfully affected by atmospherical electricity, and the plant to which they appertain, considerably influenced by this cause. The pinnate leaves of various mimosas, for instance those of the julibrissin, must be hence stimulated; and the repose of the foliage, or the activity of the leaves, may be presumed more or less obedient to its impulse.



The following phenomenon recorded in Mr. Loudon's Magazine of Natural History, can scarcely be referred to any other cause than an electric origin. The upper figure represents the sphæria fraxinea, as it was attached to the bark of an ash, from whence it was taken; the lower figure affords a picture of the singular radii, composed of a fine blue coloured powder, diffused around it, after it was left on the mantle shelf. The author of the communication detached several of these, and for eight or ten nights successively, they displayed the curious electrical figure represented. Each of the specimens being surrounded by a black powdery efflorescence, shaded off and radiated. The powder was of a fine bluish black colour, readily brushed off with a feather. The radiation took place only in the night;—never from ten A.M. to five P.M. Forests, we know, attract the storm cloud, and determine its direction, and while it thunders in the woods, the plains may escape the influence of the meteor. The *oak* most readily prompts the fall of lightning; and while the oak and a few others, as the ash, poplar, &c., have become its victims, we believe there is not a well authenticated instance of the *beech* ever having been scathed.

The flowers of the nasturtium, tropæolum majus, have been observed to emit flashes of light during twilight in the evening, and before sunrise. This curious phenomenon was first observed by a daughter of Linneus, and being referred to Wilcke, he pronounced it to be electric. Similar luminous exhibitions have been noticed on the flowers of the tuberose, polianthes tuberosa, the marigold, and some few others. It has been also seen investing the corolla of the oriental poppy, papaver orientale, appearing to hover over it like a large butterfly; sometimes resting on the tips of the petals. Subtile vapours are occasionally emitted from plants, and these may be at times ignited by atmospherical electricity: thus there appear to be glands in the flowers and other parts of the fraxinella, dictamnus alba, which secrete inflammable matter that may be kindled by a taper. We believe from the same cause the natives in some of the Spice Islands, are careful how they bring flame near particular trees. The light which flashes however from the flowers we have named, is totally distinct from the latter class of phenomena. Luminous plants appear to me to be indebted to an electric source for the peculiar light which invests them. Still, however, the luminous appearance said to have been noticed on a small moss, (dicranium taxifolium?) near Penryn, Cornwall, I am inclined, with Mr. Bowman, to consider a *deceptio visus*. I was once puzzled with a phenomenon of this kind. Perhaps too the emerald green light noticed, by Mr. De Luc, in cavities in the granite mountains, which form the boundary line betweeen Bayreuth and Bohemia, may also have been of this description; but in the case of the rhizomorphæ there can be no mistake. These curious plants are found in subterranean cellars and mines, and illuminate the darkness which surrounds them with their magic light. In some of the coal mines of Dresden, they are singularly beautiful and brilliant. Mr. James Ryan informed me he was once accidentally shut up in a mine, and the light of one of the rhizomorphæ was so brilliant that he could distinctly see to read a letter by it. As the rhizomorphæ prey on dead wood, they impart to it a phosphorescent light, The rhizomorphæ phosphorescens is found in the mines of Hesse, and yields light in the dark, but ceases to be phosphorescent in hydrogene and some other gases: the rhizomorphæ subterranea and aidula have also been found to illuminate the mine with their fairy light. Mr. Erdmann thus describes the luminous appearance of the rhizomorphæ in one of the mines of Dresden. "I saw the luminous plants here in wonderful beauty; the impression produced by the spectacle I shall never forget. It appeared, on descending into the mine, as if we were entering an enchanted castle. The abundance of these plants was so great, that the roof, the walls, and the pillars, were entirely covered with them, and the beautiful light they cast around almost dazzled the eye. The light they give out is like faint moonshine, so that two persons, near each other, could readily distinguish one another. The light appears to be most considerable when the temperature of the mines is comparatively high." That the light is electric seems most probable, when we consider that an electric discharge imparts phosphorescence to Canton's phosphorus, (calcined shells,) and that heat enhances the light.

I shall in this place take a brief survey of some remarkable examples of irritability in vegetable life, without at all, however, entering into the curious question of sensation in vegetation. Whether susceptible of pleasure or pain we cannot tell. If granted, it no doubt differs both in kind and degree from the sensations of animal life, because the phenomena of life are altogether different from each other. As in the higher orders of animal creation, there is a more perfect nervous development, feeling must be more acute than in the humbler classes, where such is only partially, or comparatively imperfectly unfolded. In like manner, there seem be be, in some particular cases, among plants, extraordinary phenomena of irritability, which appear to have a strong analogy with nervous excitation; while, in the other cases, we can detect no signs of motion, whatever be the means we employ to determine the question. Dutrochet supposes that he has detected the elements of a nervous development in plants, under the form of minute translucent globular and linear bodies, on the walls of the fibrous and cellular structure. This, however, is little more than assumption. From the circumstance of some vegetable poisons preventing the contraction of the capsule of the squirting cucumber, and that of the balsamina impatiens, Carradori concluded that plants were possessed of contractile muscular fibres. Opium, it is stated, destroys vegetable life. One of the most singular parts of the question is, that vegetable poisons prove injurious, if not destructive, even when applied to the plants from whence they are obtained.

Waiving, in this curious question, all that is merely supposititious, we may mention a variety of very singular facts connected with observed irritability, and spontaneous motion in plants. Mr. David Don, an acute and intelligent botanist, has perceived that spiral vessels detached from some plants are occasionally singularly agitated, those, for instance, that are found in the young herbaceous shoots of urtica nivea, centurea atro-purpurea, and some of the mallows. I observed in the common nettle a curious movement of this description.* Flowers frequently exhibit extraordinary evidences of irritability; the flower of the barberry has been long known for its singular phenomena: the filaments repose under the petals, but they are no sooner touched on the inner side, near the base, than they spring forward, and come in contact with the pistillum; contracting, as Sir J. E. Smith observes, like animal muscle when irritated. If the throat of the schizanthus pinnatus be slightly pressed, the stamina spring forward, and shed their pollen; as this, however, soon takes place naturally, frequent repetitions will be necessary to witness the curious phenomenon. In like manner, if the stamina of the rock rose, cistus helianthemum, are touched, they recoil, and by a sudden jerk diffuse the pollen, while they are spread on the petals. M. Desfontaines has remarked that the motions of the pistils are much more remarkable than the stamens. Braconnot discovered, some time ago, a very singular contractile power in the stigma of the mimulus glutinosus, (Wild.) or mimulus aurantiacus, (Curt. Mag.) If the superior lip of the stigma in this flower be touched with a point, it is usually reflected downwards. If the inferior lip be touched, it immediately acquires a tremulous motion, describes more than the quadrant of a circle, and finally covers the superior lip. The stamens of the rue rise spontaneously, lean over the stigma, by one or more at a time, and then change places with the rest. Thus, too, the grass of Parnassus, parnassia palustris; the anthers stretch forwards till they reach the summit of the pistils, and then recede toward the petals. When I gently pressed the tongue of the rigent corolla of the lobelia sensoides back on the gorge, an orifice opened, and discharged a miniature torrent of pollen, gliding down like quicksilver, in a quantity quite remarkable for so small a flower. The pollen seems quite continuous, as the particles in this case do not separate. Mr. Macnab informs me that the stigma of the maranta bicolor is irritable, and rolls up; the filaments of the kalmia are also found to be so. Among irritable flowers, none present more curious phenomena than the dog's bane, apocynum androsæmifolium. The anthers converge toward the nectaries, consisting of five glandular and somewhat oval bodies, which are sufficiently separated below, to admit air to the anthers. As soon as a fly introduces its proboscis between the anthers, from the top, they close so suddenly as to detain the fly a prisoner for life, for the insect generally perishes. Our figure represents both

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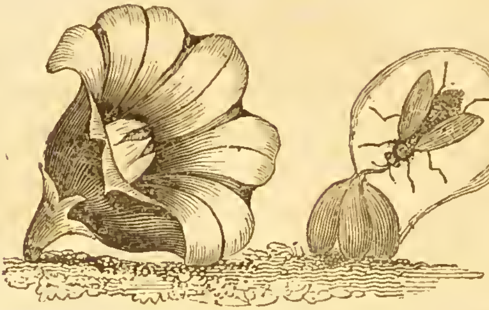
* The repeated miniature explosions of the pollen among the flowers of the common nettle, in the sunshine, as witnessed from the shade, have been compared to discharges of musketry in Lilliputian bush fighting.



the corolla and its separated anthers; as well as the anthers shut with their captive. It seems highly probable that as observation extends the sphere of its survey, so these curious phenomena will increase in interest and variety. Dr. Johnston, of Berwick, has observed a curious fact with regard to the butterwort, pinguicula vulgaris. When specimens of the plant are rudely pulled up, the flower-stalk begins immediately to curve backwards, and when the plant is deposited in the botanic case, the leaves are soon reflected, and conceal the root by their revolution. The drosera, or sundew, is a very common plant, and may be easily recognized by the dead insects it had previously caught on its leaves. The leaves of the drosera rotundifolia are studded with a number of red hairs bending inwards, which discharge globules of a viscid fluid, somewhat acid; these pearly globules, glittering in the sun, have acquired for it the name of *sundew*. It was once celebrated as the source from which 'aqua rosæ solis,' or spirit of sundew, was distilled. As soon as insects are entangled by the hairs, and the viscid matter of that exudes, the leaves themselves seem to contract, in the manner of the dionæa ' mucipula, though much more slowly, and apparently somewhat more equivocally; because it varies materially in susceptibility, as the sunshine is more or less intense. There seems to be no doubt of the fact, though it has been questioned, on certainly doubtful authority: the hairs continue to bend inward, and the leaves to fold, when insects are struggling with their entanglements, occasioned by the viscid exudation of the hairs. Linneus observes that the flowers of the drosera rotundifolia open at nine o'clock, A.M., and shut at noon. The phenomenon has been verified by correct observation in this country. It has been stated that when a fly settles on the leaf of the drosera anglicana, the leaf rolls up and remains so, till the insect is dead. The purpose which these remarkable provisions subserve, are not so obvious to us; but as a wise and omniscient Intelligence framed them, their importance must be granted, and assent cannot be rationally withheld. Whether the plants which entrap insects receive from their decomposition some gaseous product necessary to their economy, we cannot tell. We can conceive that this may not be the case, and that the viscid exudations of the catch fly, gum cistus, roridula, and others, like the pouches of the sarracenia, sheath of the arum, and leaves of the dionæa, and drosera, may be providentially intended as one of the compensation curbs in the balance of animal life, to check its multiplication, and prevent confusion, or the return of chaos. The susceptibility of the fine pinnated leaves of the mimosas, particularly of the more delicately divided kinds, must have been frequently observed. If we except the mimosa sensitiva, and mimosa pudica, none is more remarkable in this respect than the accacia julibrissin, called by the Turks, gul ibrisim, or silk rose. Dr. Walsh says, that its leaves are very susceptible of variable sunshine and shade:—"the pinnate foliage," he observes, "affords a thick shade on a bright day, but when rain impends, or even when a cloud passes over the face of the sun, the leaflets immediately close their under surfaces together, and the tree seems divested of its leaves. When the sun again appears, the leaflets re-assume their horizontal position, and expand so speedily that their motion is sometimes perceptible." The camrimga, averrhoa carambola, a native of Bengal, is susceptible of contact, and displays its irritability on being touched. Its pinnated leaves alternate with an odd one: when the leaves are touched, they bend downwards, so completely, that the lateral leaflets come into contact beneath; these leaflets may be either made to move singly or altogether; this sensibility extends to the leaf stalk: the movements seem to be produced by the action of moisture, as the phenomena are repeated naturally in the absence of light; the leaflets curl downwards, and come in contact or clasp each other at night.

The hedysarum gyrans, (desmodium gyrans,) represented in plate II. figure 11, is a native of Bengal, near the Ganges, and was introduced in the year 1775, into this country, by Dr. Russell. When the air is very warm, and quite tranquil, its leaves are in constant motion; some falling, and some rising; while others, by untwisting their stems, are whirled circularly; this singular motion appears altogether independent of external impressions, even of light. A warm and still atmosphere seems to be the only requirement. Sir J. E. Smith says, 'each leaf is ternate, and the small lateral leaflets are frequently moving up and down, either equally or by jerks, without any uniformity or co-operation among themselves.' It seems to be altogether an irregular and apparently voluntary motion; sometimes many leaves are moving in various directions: sometimes one leaf or leaflet, and occasionally the leaf seems to tremble. It is completely quiescent in a strong wind, or bright sunshine, or on very hot days. This curious plant is about three feet high; the leaves are of a bright green colour; with a tinge of sea green in the middle; the flowers are a pale red, slightly tinted with blue or yellow.

The dionæa mucipula, or fly trap, a correct figure of which is represented at 13, plate 11. is copied from Mr. Ellis' work,* the description of which forms an appendix in a letter to Linneus. The dionæa mucipula is a native of the swamps of North Carolina, and the plant seems to grow in shady wet places, flowering in July and August; the leaves terminate in a distinct and peculiar appendage precisely resembling a spring rat-trap—it is supplied with long and sharp teeth on the margin, like the teeth of a saw, which lock into each other, when the leaf shuts. This attachment is also supplied with six spines, three on each side; these are so excessively irritable, that whenever an unfortunate fly happens to alight on the surface, the leaf snaps, and crushes in a moment the insect to death. Mr. Ellis observes, in his announcement of it to Linneus, "many minute red glands, that cover its inner surface, and perhaps discharge sweet liquor, tempt the poor animal to taste them; and the instant these tender parts are irritated by its feet, the two lobes rise up, grasp it fast, lock the rows of spines together, and squeeze it to death. And further, lest the strong efforts for life, in the creature thus taken, should serve to disengage it, three small erect spines are fixed near the middle of each lobe, among the glands, that effectually put an end to all its struggles." The dionæa mucipula was first brought to this country in the summer of 1768, by Mr. Young. Mr. Knight, now a respectable nurseryman, tried a curious experiment with the dionæa. Two separate plants were imprisoned under bell glasses; the trap of one of these plants was supplied with filaments of raw muscle, and the other not: the consequence of this was, that the former seemed to be healthy and luxuriant, while the other became weak and sickly. We have seen a great many fine plants of the dionæa mucipula in this country, but none so fine as those in the Liverpool botanic garden. The soil that seems to suit them is a dark peat earth, somewhat sandy; the flat in which the pot rests, should be constantly supplied with water; and moss, or the spagnum, should invest the surface of earth round the plant; and a bell glass, slightly tilted, should cover the whole. The leersia lenticularis exhibits on its husk, a miniature copy of the fly trap of the dionæa mucipula.

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* Directions, &c. London, 4to, 1770, p. 35.

The sensitive plant, mimosa sensitiva, is the most generally known; this, and the mimosa pudica, are easily reared in the hotbed, and are very frequently so. There is in these a double, perhaps a treble motion, which supervenes on the gentlest contact: the leaflets fold up, one after another, as soon as the contact is communicated, as it were along a line, in a kind of running motion; this done, the petiolus falls at the joint. According to some experiments of Mr. Burnett, when the pinnate branch has fallen, and is blackened, it is much more tardy in recovering its natural position; he also finds that it *changes colour*, at the moment the parts are touched to produce motion. These susceptibilities appear to reside at the base of the foot-stalk, and the middle rib, to which the leaflets are attached; or rather in the joints or articulations by which they are connected. The period required for recovery varies according to circumstances, such as sunshine and temperature, and the vigour of the plant, sometimes in ten minutes; at other times it requires half an hour. Towards noon, the plant seems to be more languid than in the morning, and a gentle touch or irritation will sometimes produce that effect, which cannot be accomplished by a complete incision or section. When prussic acid is applied to the leaves of a sensitive plant, they collapse, and open at the termination of a quarter of an hour, but do not regain their sensibility for six or eight hours.* The leaflets fold together at night, when the plant reposes, but the footstalk does not droop. The most delicate seat of sensibility resides in a small light coloured spot, paler than the rest. The distinct movements referred to can be repeated independent of one another; thus the footstalk may be made to fall, while the leaflets continue expanded. A sensitive plant was carried into a dark cave, and the motion of the carriage caused its leaves to collapse. In the cave, they shewed no tendency to open for nearly twenty-four hours, and then but partially opened. In this state they continued unchanged for three days and three nights; but recovered their usual sensibility on their return to light. Some observations were made by Duhamel on the angles which a branch of the sensitive plant subtended with the stem. In fine weather, the angle at 8 A.M. was 135°, after being touched, the angle fell to 80°. In an hour it rose again to 135°, and again sunk to 80° after contact. In an hour and a half it rose to 145°; on contact it fell to 135°, and remained so till 5 P.M., when being again touched the angle was reduced to 110.° The leaves of the smithia sensitiva,† and oxalis sensitiva, are also sensible to the touch; and the petals of some of the flowers of the orchis tribe possess a spontaneous motion.

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* Seeds steeped in prussic (hydrocyanic) acid, are said to lose their germinating power.

† So called in honour of the late eloquent President of the Linnean Society, Sir James Edward Smith.

The oscillatoriæ present remarkable evidences of motion in their filaments, of an oscillating kind, but the difficulty is to determine whether they really belong to the animal or vegetable kingdom. They are found connected with thermal springs. The oscillation of the filaments seems independent of any extraneous action. Mr. Carmichael has paid considerable attention to this curious question. They appear to have a short-lived existence; in mass their continuance is for several months; but the individuals forming the "community" soon perish, and are succeeded with remarkable rapidity by others. "If a watch glass," observes Mr. C., "charged with a small portion of the substance, be laid aside for a night, it will be found that by the next morning, not only a considerable radiation has taken place, but that multitudes of the filaments have entirely escaped from the stratum, both indicating motion independent of light. Rapidity of growth will show itself in a prolongation of the filaments, but will not account for this oscillation to the right and left; and still less for their travelling in the course of a few hours, to the distance of ten times their own length from the stratum." Le Chevalier Carlo di Gimbernat discovered this remarkable substance in 1818, in the island of Ischia, in the Gulf of Naples: it mantled the rocks exposed to the humid vapours of the hot springs, which have a temperature of 60° R. in the ravine of Negroponte, at the foot of the mountain Epommeo. M. Di Gimbernat informed me that when the natives were employed cutting the substance from the rock, they frequently exclaimed 'Carne,'

'carne'—*flesh, flesh;* and when I saw the substance, at Naples, in 1818, I must confess it appeared to me remarkably like animal muscle. On my return to this country, I shewed a portion of it to a physiologist of considerable talent and eminence, who unhesitatingly pronounced it to be animal muscle. It soon passed into the putrefactive fermentation, evolving ammonia. In water, aided by heat, I found that it formed a solution like animal glue, and by the action of nitric acid, a substance was produced of the nature and consistency of adipocire. As to the nature of this curious organic substance, I confess I am inclined to consider it as belonging to the animal kingdom. M. Di Gimbernat found it at Aix, in Savoy, and subsequently at Yverdun. I may extract a paragraph from one of his letters to me, wherein it will be seen that Mr. Carmichael's observation respecting the rapidity of growth is fully confirmed even at a comparatively low temperature. "Elle y forme des membranes qui oscillent dans les eaux thermales, ce qui rend propre la denomination *d'oscillatoires.* A l'aide d'un fort microscope on y découvre des globules dont les mouvemens ne permettent guère de douter de leur animalité. Quoique la substance organique se forme à des temperatures assez élevées, le froid est plus favorable à sa production, et par cette raison on en rencontre bien plus en *hiver* qu'en été. Je l'ai vu se former *instantanément* à Aix en Savoie a la faveur du froid, l'air etant 30° R. moins chaud que l'eau thermale, dont la température est de 37° R. *Des conferves s'établissent sur la substance organique* a la maniére que les plantes parasites sur les ecorces des arbres. Cest pourquoi on les regarde comme telles; mais en les examinant scrupuleusement on voit une membrane gelatineuse, absolument differente des conferves.'' Professor Ehrenberg ascribes the colour of the red sea to minute oscillatoriæ.

The effects of light on the flower have already been considered; and its absence produces phenomena of an opposite kind. According to the experiments of Bonnet, heat and moisture alone will not account for the nutation of plants, or their inclination toward the source of light, remarkably exemplified in a field of wheat, every ear of which inclines to the south; nor will their modification solve what Linneus, with great propriety, designates the 'sleep of plants.' The corolla shuts, the leaves fold up, and gradually do so, in many cases, as the evening advances. Even in dark and gloomy weather, some plants but partially unfold their leaves and flowers. During night the repose is more settled and complete, and none can have traversed the meadow, in the evening twilight, without observing that the leaves of a clover field are folded up; and the flowers of the daisy and buttercup shut. Pinnate leaves, as those of the liquorice, the various acacias and mimosas, and the kidney-bean, exhibit evidences of the sleep of plants. The perianthium of the amaryllis candida contracts and expands under the influence and absence of light. The leaves of the tamarind tree are said to fold over the young fruit to protect it from the chills of the night. The common chickweed affords a curious instance of the sleep of plants. Each night the leaves approach in pairs, and include within their upper surface, the tender rudiments of the new shoots, while the uppermost pair but one, at the end of the stalk, are furnished with longer leaf-stalks than the others, so that they close in the terminating pair, and mantle the end of the branch. We have already adverted to nocturnal infloresence, wherein, like the bats and moths in the animal kingdom, there are flowers that shun the light, and in these no doubt light would be hurtful, for as soon as the sun has risen upon them, they wither away. It must have been apparent, from what has been already said, that the absence of light will occasion the sleep of plants, since its stimulus operates so powerfully in the expansion of the flower. Dutrochet considers that the sleeping and waking of plants, as well as their nutation, are phenomena dependant on the *air* contained in the air organs. In order to prove this, Dutrochet took three leaves of the kidney-bean, one of these placed in water, and introduced into the air pump, was charged with water; another remained in vacuo, simply, and the third was suffered to remain in the atmosphere. The first leaf became the first depressed, the second leaf was later, and the third still more tardy; the first awoke later, and the second seemed passive in its return to wakefulness, nutation was confined to the third leaf, which also slept later, and awoke earlier, than the others. A flower introduced into an air pump, preserves the same state it had previously possessed; if fully expanded, it has no power to sleep, when night comes on; and if the flower be shut on its introduction into the vacuum, the sunbeam has no power over it—it wakes not. I have already mentioned that 'everlastings' close on their introduction into water, and the sunshine cannot awaken them. The rose of Jericho is just the reverse. The convolvolous will open and shut in water as when attached to the parent stem.

CHAPTER XIII.

The Age of Plants—Decay of Plants—Perpetuity of Vegetation—Conclusion.

Some plants are short lived—transient and ephemeral, they soon pass through the circuit of their vegetation; they flourish, and they fade in a few hours. Others, however, outlive the wreck and ruin of centuries, and in the term of their duration, very far exceed that of animal life, as far at least as is known to us.

It may be well to single out a few of the more remarkable of these aged trees, and then give the data on which their age is commonly calculated. Humboldt mentions a cypress, cupressus disticha, seventy-six feet in circumference at the village of Atlixco, in the intendancy of Puebla, Mexico: this he considers may be the 'oldest organic monument on the surface of the globe.' Of course, this can be only mere conjecture, since we have no data assigned, and there are trees of still greater magnitude.

There is a cypress, taxodium, in the church yard of Santa Maria de Tesla, on the road to Guatemala, of enormous dimensions. It is called by the natives *sabino,* appears to be 127 feet in circumference, and has not a dead branch. Some of the enormous branches that spring out of the trunk, are thirty feet high; the stem seems as if there were three or four trees united, and is altogether 120 feet high. This cypress is an object of great veneration with the natives and surrounding Indians. It is even said sacrifices were formerly made to it. Beneath the shade of this tree Cortez and his little band encamped.

The famous cypress of Montezuma, in the gardens of Chapultepec, near Mexico, had attained its full growth when Montezuma was on the throne, 1520. Its circumference is forty-one feet; and its altitude has a corresponding magnificence. Mr. Ward mentions another of these cypresses, thirty-eight feet round, and as tall as the cypress of Montezuma: the dragon tree of Orotava, in the garden of Franqui, is about sixty feet high, and forty-eight feet in circumference. In the year 1402, at the period of the expedition of Berthencour; it should seem that it was as huge a vegetable pile as it appears to be now. This tree is of tardy growth, and may be presumed of considerable age. The chief interest connected with it, is the fact of its being indigenous to the continent of India, and not found as a native of the New World.

The celebrated chesnuts of Ætna, however, merit particular notice. Many chesnuts thrive on the flanks of Ætna. One is thirty eight feet in circumference: the 'Castagno de Santa Agatha' is seventy feet in circumference; and the 'Castagno della Nave,' sixty-four feet in circuit. A group of seven are called 'the seven brethren:' the most celebrated of all, however, is that called the 'Castagno de' Cento Cavalli,' or the chesnut of a hundred horse. Legend states that when Jane of Arragon visited Sicily, on her voyage to Naples, from Spain, the party, consisting of one hundred on horseback, were overtaken by a storm, and found, within the precincts of this venerable tree, sufficient shelter and protection. This patriarch tree *seems* to consist of five larger and two smaller trees, being apparently discontinuous: the tree is quite a shell, and within the trunk has been erected a house for drying and preserving nuts, almonds, and chesnuts: of this tree they even make firewood. According to Houel, it is 160 feet in circumference; others make it 163 feet. Brydone admits there was the appearance as if these five trees were once united in a common trunk; and Recupero, who was at the expense of digging round the tree, to ascertain the fact, assured him that they were united in one common root below ground. Houel, in 1784, ascertained satisfactorily the same fact, and states that the hollow made in the trunk is really the work of the peasantry, arising from continually using the bark and wood for fuel. Dr. Schouw, who visited this celebrated tree in 1818, assured me he had ocular demonstration that these apparently distinct trees were really united into one below ground, and had been one uniform trunk originally, as he had complete and satisfactory excavations made for this purpose. I consider the question decidedly set at rest.

The adansonia digitata, however, has afforded Adanson a considerable latitude. By enumerating the concentric rings in a huge boabab in Senegal, he inferred it to be no less than 5150 years old. We cannot however see clearly how this could have been done. That the boabab has attained a patriarchal age there can be no doubt; but the data on which such milleniary duration has been founded, seem to be more than questionable. In the boabab, represented in Macartney's embassy to China, the trunk is twin; and the fact of such a phenomenon occurring in this tree may well induce a reasonable scepticism. In the case of limes, I saw, some time ago, in an avenue at Powis Castle, I am quite certain, from the coalescence of several trunks, that the usual method of calculation would by no means apply. But the greatest measure of time assumed by any one party will be sure to be exceeded by another; accordingly, Decandole considers that the celebrated cupressus disticha, or taxodium, of Chapultepec, in Mexico, is still older than even Adanson's boabab. The largest boabab somewhat exceeds 100 feet in girth.

There were, in 1776, in the palace garden of Grenada, several cypresses, which formed a cypress grove, and computed to be eight or nine centuries old.

Pliny mentions a plane tree in Lycia, hollowed out into a cave, eighty feet in circumference; there is an oriental plane in the valley of Bujukdere, near Constantinople, which embraces a circuit of 150 feet, and has a cavity of eighty feet circumference. The oriental plane of Stanchio, an island in the archipelago, formerly Cos, is remarkable for its size, and no doubt has a corresponding age. Earl Sandwich, in 1739, measured forty-five paces, from the trunk to the extremity of the branches; these branches are supported by pillars of marble, verde antique, and porphry; and though time has assailed it, it is still immense. "Some notion," says Dr. Clarke, "may be formed of the time those props have been so employed, by the appearance of the bark: this has encased the extremities of the columns so completely, that the branches and the pillars mutually support each other: and it is probable, if those branches were raised, some of them would lift the pillars from the earth."

There is a yew tree at Peronne in Picardy, which was known to be flourishing in 634; it still existed in 1790, consequently was 1156 years old: there is also an Italian fig, in the Isle of Thanet, supposed to have been introduced by the Romans in the first century. The yew near Staines, at three feet high is nine feet three inches diameter, and the extent of its branches embrace a circle of 207 feet: that it is of a very considerable age there can be no doubt.

Eight olive trees still remain on Olivet, said to be 800 years old; and it is ascertained that they existed prior to the capture of Jerusalem by the Turks. Mount Lebanon, and the range of the Taurus, are the native soil of the cedar of Lebanon. It is a magnificent and beautiful tree, and several very venerable and noble specimens still decorate the flanks of Lebanon. According to Labillardière, the largest of these patriarch trees is at least nine feet in diameter. The trees are still held in great esteem, and an annual festival is celebrated beneath their shade, called the 'feast of cedars.'

In the garden of the Duke D'Aremberg, at Brussels, is a linden tree, which, according to the records of the city, is more than 700 years old. In the canton of the Grissons, is a lime which measured fifty-one feet in circumference in 1798, and is recorded to have existed in the fifteenth century.

Of 'goodly' oaks, of immense size, and venerable in years, Britain has her full share, so that our island may emphatically be denominated the land of the oak; but with these the public is sufficiently acquainted, and they have been well described and registered. In Blenheim Park there still exist the ruins of trees which Legend says once shaded the retreat of the Fair Rosamond.

There is a curious tree, and the only one among the ruins of Babylon, near the kasr or great western palace, called by the native Arabs, Athélé. Sir Robert Ker Porter describes it as still possessed of "spreading and evergreen branches: they are particularly beautiful, being adorned with long tress like tendrils resembling heron's feathers, growing from a central stem. These central and delicate sprays, bending toward the ground, gave the whole the appearance of a weeping willow, while their gentle leaves in the wind make a low and melancholy sound." According to the authority of Captain Mignan, it would seem to be a beautiful variety of the tamarix orientalis, called by Mr. Rich, though improperly, a lignum vitæ. It appears to be of the greatest antiquity, and has once been a superb tree; in all probability, a scion of some monarch of the pensile gardens, when Babylon was in its splendour, and

Nebuchadnezzar reigned. Captain Mignan says "the fluttering and rustling sounds, produced by the wind sweeping through its delicate branches, has an indiscribably melancholy effect, and seems as if entreating the traveller to remain and muse in mourning over fallen grandeur." See plate I. fig. 2, copied from Sir Ker Porter's work.

The celebrated banian tree, on the banks of the Nerbudda, (plate I. fig. 1.) is a magnificent organic monument. The rising floods have often invaded its domain, and much of it has been swept away—still it is

> ' A vast and venerable pile.'

It exceeds 2000 feet in circumference, calculating the circuit of the main trunks, but the extremities of the branches cover a far wider extent. The main stems of this wonderful tree, ' itself a forest,' amount, in all, to the number of three hundred and fifty, while the inferior ones are more than three thousand. These are incessantly detaching new rooting stems, to increase the columns of the ' pillar'd shade,' each of them becoming in turn the parent stem to a multiplied offspring.

> ' ————— In the ground
> The bended twigs take root, and daughters grow
> About the mother-tree, a pillar'd shade,
> High overarch'd and echoing walks between.'

This tree is on an island, in the province of Guzerat: it is distinguished by the name of ' cubbeer-burr,' given in honour of some Hindoo saint, and the tree is celebrated throughout Hindostan for its majesty and beauty.

Indian armies encamp around it, and Hindoo festivals are celebrated in its groves. It is stated that seven thousand persons can here find shelter and repose. Its arbours and branches are filled with wood pigeons, turtle doves, and peacocks. The figs which the banian bears are a rich scarlet, and afford a delicious fare to its feathered inmates, as well as the squirrels and monkeys, which abound there. Its dark recesses are illuminated by night, with myriads of fire-flies; the pelican of the wilderness flies to its shades; and the Brahmin cultivates his devotions amid its solitudes, in the vicinity of the pagoda erected near;

> ' And finds a fane in every sacred grove.

The method of calculating the age of palms can only be considered an approximation, as they are endogenous in growth. Certain cocoa nut trees in the Brazils have been computed at six or seven hundred years, while others again may have outlived some centuries less; the hard rings seen in the transverse section of many kinds of wood are supposed to indicate the age of an exogenous tree. In the fir trees, that skirt the line of perpetual snow, thirty or more annual rings have been observed in a tree, not more than two inches diameter. It may be concluded that in such trees, these rings, each of which corresponds to an annual cylinder of bark, would be tolerably accurate if they were uniform, but as an error to the amount of sixty per cent. might be committed by the circumstances attending an irregularity of the layers, arising from accident; the excessive age claimed for the deciduous cypresses and boababs may be founded in complete mistake. A wound on one side would throw the great extension or protrusion of wood to the opposite side. In the case of a duplicate trunk, as in some boababs which may conjoin, and form an individual stem; it is obvious such a mode of computation could afford no accurate result.

Adanson mentions an immense tree in the Cape de Verde Islands, in which he discovered an inscription under three hundred layers of wood, hence the date of this inscription must have been three centuries previous to his observation. It is, however, not in every case we can obtain such tangible data. In Sherwood Forest, some trees were cut down at different periods. One oak exhibited the letters I and R for King James; these letters were about one foot from the centre; the oak was felled in 1786. Another had the letters W.M. and a crown, about nine inches within the tree, and three feet three inches from the centre; this was also felled in 1786. One presented the letter I for John, (with a blunt radiated crown,) was 18 inches within the tree, and more than a foot from the centre; it was cut down in 1791; the outer plate of wood in the first had the letters in relief, while its counterpart had them in intaglio. Where the bark had been stripped off for cutting the letters, the wood, which grew over the wound, never adhered to that part, but separated of itself, when the wood was cut in that direction.

The galenos oak grew near Newport, South Wales:—the main trunk produced four hundred and fifty cubic feet, and sold for nearly six hundred pounds. The number of ligneous cylinders amounted to upwards of four hundred. In the bole of the tree, a stone was found six feet from the ground, and more than three feet within the trunk: the stone was six inches in diameter, and completely imprisoned, without any apparent symptom of decay around it. Near Newport, also, in cutting up an oak plank, a gold coin was found toward the centre of the wood.

Hitherto we have considered the plant as arrayed in a mantle of green, and adorned with its flowers; its plume waving gracefully in the breeze, and blossoming in beauty. Its silent machinery is put in motion by the principle of life—it is thus preserved and perpetuated, and its image and type transmitted to futurity. While this principle continues to preside, all goes on well; the plant unrolls its leaves, unfolds its flowers, and matures its fruits; and if it sheds its leaves in autumn, it obeys the genial influences of the spring, and blooms again. As soon however as this principle ceases to animate the plant, all is reversed; a new scene unfolds, and newphenomena are announced. Before this event in the annals of its history, chemical changes were overruled; and chemical principles subordinated and controlled; now, however, these, before obedient, gain the ascendancy, and the changes that supervene thenceforth yield to the laws of chemistry alone. To-day, the plant stands forth a living being, and a beautiful organized structure; while the streamlets of life meander in its veins and supply its pulse. To-morrow, it suffers an eclipse, 'the silver cord is loosed,' and it charms no more: it is leafless, lifeless; its beautiful flowers are the sport of the winds, and its once erect stem droops and falls: the fountain of life is dried up; the animating principle which preserved its organization, and prevented its parts from mingling into confusion, hath fled. The parts uncontrolled, now act and re-act on each other; while the chemist stands by to watch the progress of the ruin, trace step by step the advances of decay; and with his alembics and his crucibles, 'to wring the shy retiring virtues out, and vex them in the fire.'

What the principle of life is, we pretend not to know, nor do we hazard any fruitless conjecture on the subject. The phenomena prove that it is not chemical in its nature; on the contrary, it is superior to chemical phenomena, for it subjects them to its government. It cannot be electricity, since we cannot conceive under what circumstances, in the condition of plants, it could be so insulated in them, as to operate. The principle of electricity may indeed affect it, but electricity seems to be rather the medium by which it operates on the chemical changes which supervene, than the principle of life itself. It is more refined than any of these. It is not tangible, and all our processes are unable to catch and confine it. It is a gift superadded to the material form, curious and wonderful; it seems distinct and independent of the most subtile principles with which we are acquainted, and is altogether different in nature from that which animates the realms of zoology. "I humbly conceive," says Sir James Edward Smith, "that if the human understanding can in any case flatter itself with obtaining, in the natural world, a glimpse of the *immediate agency* of the DEITY, it is in the contemplation of this *vital principle*, which seems independent of material organization, and an impulse of his own divine energy."

The remarkable changes which supervene in the decay of the plant, fall under the cognizance of the chemical philosopher, and do not, in one sense, belong to our department. A series of preparatory and intermediate steps, strictly chemical in their phenomena, conduct us to the final issue of decomposition and decay. For the reciprocal action of the integrant parts of the vegetable structure, two conditions are necessary; namely, air and moisture; while temperature will stipulate the greater or less rapidity of the mutations that follow. The vinous, acetous, and putrefactive fermentations may be considered as characterized by their respective products, but which we shall not examine or discuss. The subordinate agencies of air, moisture, and heat, however, which before aided in the evolution of the plant, now assist in its ruin and decay. In vegetation, when subjected to vinous fermentation, carbonic acid gas is expelled, and being quit of this counterforte, it is prepared at a favourable temperature, to glide into the acetous change; the intermediate step toward the last great phenomenon of final decomposition, which resolving the materials into ultimate and simple forms, the conflict is finished, and is succeeded by undisturbed repose. The compound may indeed be separated into its ultimate material constituents, but this does not in the very least impair the susceptibility of their re-union Matter cannot be destroyed; 'nothing,' said the wise, the sober, and circumspect Newton, 'can tear in sunder what DEITY made one in the beginning.' These scattered elements, it is true, would remain unchanged, like the blanched bones in the valley of vision, till a similar fiat passed over them, as in the first creation; they would then start from their slumber; but can be aroused by no other spell. Not a solitary figure we believe has been added to the original types of creation, as far as genera are concerned, in the animated physiognomy of the globe. 'Hitherto and no farther,' is an interdict which DEITY has imposed on his living creation, as well as on the waves of the sea. This great truth seems to be indelibly stamped in the laws of hybridism, both in the vegetable and animal kingdom: were it otherwise, the scene of uproar and confusion would be interminable. But while the natural genera of vegetation are thus prevented from mingling to form the 'palpably obscure;' the 'vital principle is transmitted to posterity, and the species continues to flourish.'

The permanence of vegetation is justly entitled to our attention. In the geographical distribution of plants there is much to interest; and much to demonstrate the intelligent design of infinite wisdom. In like manner, there is here a peculiar and striking feature. The palm, among the princes of the kingdom of vegetation, the fig tree, and the olive tree, still characterize the 'Land of Promise,' though Palmyra and Jericho are no more: the cedar of Lebanon still vindicates its claim, by imprescriptible right, to the domains of its ancestry, though Tyre, and her 'merchant princes,' are as though they had never been. Bashan is still celebrated for its oaks, as in the times of the Kings of Judah: the olive still flourishes on its natal soil, the acclivities of Olivet, as when it formed the peaceful retreat of a chosen band: the 'amaryllis lutea,' the 'lily of the field,' still decorates the fields of Palestine, as when 'the Prince of Life,' pointed to it as a pledge of his providence: the Sycamore (ficus sycamorus) still springs up by the way side, and skirts the shores of the Sea of Galilee, as in the reign of Herod Agrippa: Sharon is still as famous for its roses, as when its celebrity was chaunted by the royal naturalist: the willow still weeps by 'Babel's stream,' the Euphrates, though Babylon 'is fallen—is fallen:' the 'paper reeds by the brooks,' still justifies the description, and maintain their place, as they did ere Thebes had opened 'her hundred gates,' or the temple of Karnac was reared: the lotus floats on the waters of the Ganges, as it was wont to do before superstition had excavated the temples of Elora. Egypt is still famous for its 'cucumbers, and melons, and leeks, and onions,' as it was before the exode. Parnassus still wears its symbolic tree, as in classic times.

From our previous remarks, it must have been sufficiently evident that we have no community of feeling either with those who entirely exclude the Creator from his works, or approach the precincts of that opinion, by excluding his providence. For my own part, I perceive every where around me traces of unerring wisdom and omnipotent skill, from whence emanates a beneficence boundless as creation; and methinks if atheism had built her 'nest among the stars,' there is, amid the wonders of vegetation, more than enough to hurl her from the battlements she has so impiously scaled. I confess I see in these emphatic expressions of intelligence, something more beautiful as to the forms of that vegetation, and more wonderous in its adjustments and adaptations, than some individuals who no doubt claim, and justly, loftier pretensions to scientific fame than myself; but lowly, though the author of this little volume be, he will yield to none in contending for the truth, and maintaining its cause.

I must frankly avow that crystallization considered as an effect of *vitality;* with innate vegetable instinct; and prescience in caramanian pigeons; are discoveries I affect not to comprehend, and announcements for which I was not prepared.

The German poet taught that a plant was only composed of two parts—an axis, which comprised stem and root, and the axal appendages, consisting of *leaves;* moreover, that under whatever appearance 'leaves' were presented, whether flowers or fruit; whether calix or seeds, the evidences of our senses must be resigned, they are merely *leaves,* by Goëthe's 'special command:' truly this would have been quite a climax for the witty Dean! We read of the metamorphoses of Ovid, but they seem surpassed by the metamorphoses of Göethe. Now this was not brought forward in jest, or as fiction; but as sober science, by Mr. Brown in 1816. Nor are these views peculiar to this celebrated botanist, of whose practical botanical acquisitions none can be a more sincere admirer than myself—but Decandole, of Geneva, is an advocate of the same unintelligible gibberish, and in some of his extravagancies goes if possible, even farther. Mr. Lindley, a most laborious botanist, seems quite charmed with this rhapsody; accordingly, as 'in duty bound,' the beautiful contrivance of the ascidium in the nepenthes is defined to be 'a dilated folliacious foot-stalk with coherent margins.' I must leave this definition, as I find it, nor make an attempt at explanation, as it far surpasses my comprehension. According to these marvellous discoveries, a plant is a very mechanical affair;—a mere wheel and axis! Surely such aberrations have no pretensions to the name of science; but let the candid reader be the umpire.

To the intelligent mind, the kingdom of vegetation presents remarkable illustrations of a supreme CREATOR,

> 'Not a tree, a plant, a leaf, a blossom,
> But contains a folio volume.'

The philosopher who was cast away on an island, on seeing geometrical figures on the sand, exclaimed 'Inhabitants are here;' in like manner, when we survey the physiology of plants, do we receive demonstrable proofs of their infinitely wise AUTHOR;—

> 'Maximus in maximis, maximus in minimis;'

whether we survey vegetable grandeur in mass or in detail; or the humblest moss that 'springeth out of the wall.' Studies such as these have a tendency to soften and to soothe the mind. It is then no light enjoyment

> 'To consider the lilies of the field how they grow;'

—'Is it not a privilege to walk with God in the garden of creation, and hold converse *with his providence?*'*

FINIS.

CORRIGENDA.

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„ 47 „ 18, „ Pinot.
„ 57 „ 16, „ Nulli.

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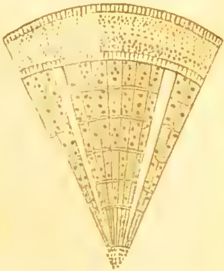

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